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Dimensions of Gear Teeth in the Metric System.

BY PEDER LOBBEN.

Although I am not an enthusiastic admirer of the metric system of weights and measures in mechanical calculations, I believe the metric system can be applied just as conveniently in gear calculations as the well-known American diametral pitch system, which everybody who is at all familiar with gear work knows is admirably well fitted for its purpose.

The "diametral pitch" in the American system is the quotient obtained by dividing the number of teeth in the gear by its pitch diameter in inches, and from this quotient all the other dimensions of the teeth are calculated. In the metric system it is convenient to divide the pitch diameter of the gear in millimeters by the number of teeth in the gear, and from the quotient, which indicates the size of the tooth, all the different dimensions of the teeth may be calculated.

In the following table this quotient is given in the first column marked m. The last column, marked P in the table, gives the nearest corresponding American diametral pitch. For instance, pitch No. 1 means that there is one tooth in the gear for each millimeter of the pitch diameter, and its nearest size in American measure is 24 diametral pitch. Pitch No. 6 means that there is one tooth in the gear for each six millimeters of pitch diameter, and its nearest size in American measure is 4 diametral pitch. Pitch No. 10 means that there is one tooth in the gear for each ten millimeters of pitch diameter, and its nearest American measure is 2½ diametral pitch.

The accompanying cut, Fig. 1, illustrates, in full size gear teeth, No. 10 metric pitch, and Fig. 2 illustrates in full size gear teeth of 2½ diametral pitch.

Dimensions in this table are calculated by the following formulas:

$$m = \frac{D}{N}$$

$a = m$ expressed in millimeters.

$t = m \times 1.5708$ millimeter.

$d = m \times 1.15708$ millimeter $= a + c$.

$c = m \times 0.15708$ millimeter $= \frac{t}{10}$

$d_1 = m \times 2.15708$ millimeter $= a + d$.

For meaning of notation see Fig. 1, also top of table.

Dimensions of the gear may be calculated by the following formulas:

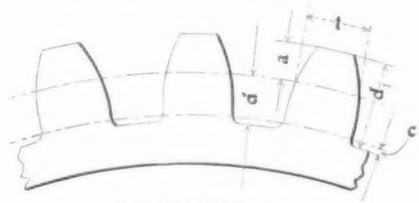
$D = m \times N$.

$$N = \frac{D}{m}$$

$D_1 = m \times (N + 2)$.

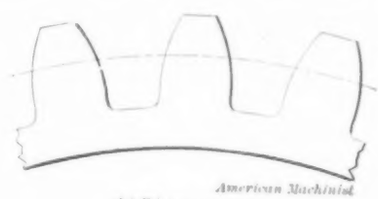
N = number of teeth in the gear.

D = pitch diameter of gear in millimeters.



Metric Pitch No. 10

Fig. 1



2½ Diametral Pitch

Fig. 2

Metric pitch number.	Addendum, in millimeters.	Depth of tooth inside the pitch line, in millimeters.	Clearance at bottom of tooth, in millimeters.	Full depth of tooth, in millimeters.	Thickness of tooth on pitch line, in millimeters.	Nearest size in diametral pitch.	Metric pitch number.	Addendum, in millimeters.	Depth of tooth inside the pitch line, in millimeters.	Clearance at bottom of tooth, in millimeters.	Full depth of tooth, in millimeters.	Thickness of tooth on pitch line, in millimeters.	Nearest size in diametral pitch.
m	a	d	c	d_1	t	P	m	a	d	c	d_1	t	P
1	1	1.16	0.16	2.16	1.57	24	4	4	4.63	0.63	8.63	6.28	6
1¼	1.25	1.45	0.20	2.70	1.96	20	5	5	5.79	0.79	10.79	7.85	5
1½	1.50	1.74	0.24	3.24	2.36	16	6	6	6.94	0.94	12.94	9.42	4
1¾	1.75	2.03	0.28	3.78	2.01	14	7	7	8.10	1.10	15.10	11.00	3½
2	2	2.32	0.32	4.31	3.14	12	8	8	9.26	1.26	17.26	12.57	3
2½	2.50	2.90	0.40	5.40	3.93	10	9	9	10.41	1.41	19.41	14.14	2¾
3	3	3.47	0.47	6.47	4.71	8	10	10	11.57	1.57	21.57	15.71	2½

DIMENSIONS OF GEAR TEETH IN THE METRIC SYSTEM.

D_1 = outside diameter of gear in millimeters.

Example:

Calculate a gear No. 6 metric pitch having 120 teeth.

Pitch diameter $D = 6 \times 120 = 720$ m m.

Outside diameter $D_1 = 6 \times (120 + 2) = 732$ m m

Depth of tooth $d_1 = 6 \times 2.15708 = 12.44$ m m

Thickness of tooth on pitch line $t = 6 \times 1.5708 = 9.42$ m m.

Nearest American diametral pitch $P = \frac{254.}{6} = 4$.

The drawing shows involute teeth, but the same proportions may, of course, be used to just as good advantage with teeth of the epicycloidal form.

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Aluminum Oil Cups.

Aluminum has lately found its way extensively into vibrating and reciprocating machines, both large and small. Here the advantageous use of the metal is entirely a matter of reducing the weight. Probably the best illustration of the use of aluminum in revolving machinery is in using an oil cup on the driving wheel of a locomotive in connection with a driving rod. With the increased speeds that the roads are now aiming to attain, it is necessary to increase the diameter of the driving wheels, and consequently the tendency to break the shank of the oil cups materially increases, and with some of the large engines which have been built cups made of composition are frequently broken. These cups, says an American exchange, are now, and have

been for some time, successfully cast in aluminum, and have given great satisfaction.—The Engineer.

It would be interesting to know how increased diameter of driving wheels "materially increases" the tendency to break the shanks of oil cups. It would seem at first blush as though large wheels would decrease this tendency.

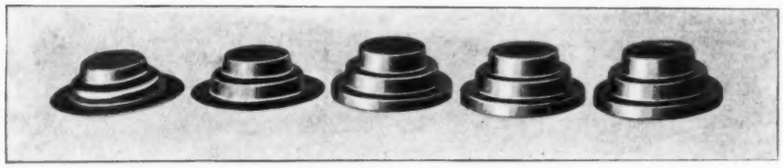

FIG 1—THE SERIES OF WORK DONE.

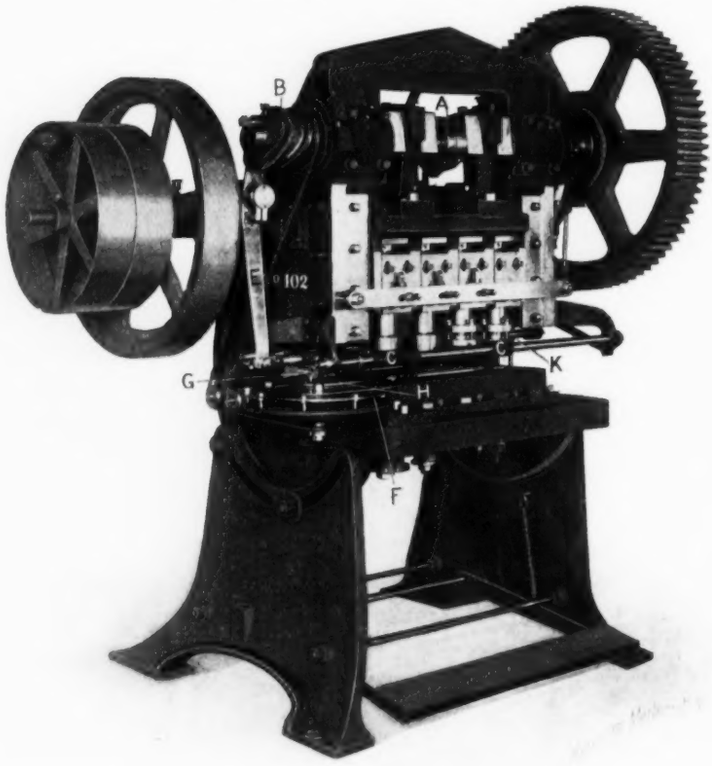

FIG. 2—COMBINATION PRESS WITH AUTOMATIC FEED.

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An Automatic Four-Plunger Drawing Press.

The half-tones herewith illustrate an automatic drawing press and punch possessing a number of interesting features. Fig. 1 shows the article operated upon, a brass burner cap, first as it comes to this machine from a double action press which cuts it from the sheet and makes the first draw, and then after each of the four successive operations performed by this machine. These operations occur simultaneously, so that when the press is in full operation a piece is completed and ejected for each revolution, the permissible speed being up to 60 per minute. The only hand work required in operating the machine is the placing of the blanks upon the constantly revolving horizontal plate *F*. This plate, driven by the little round belt, is flat and smooth, and the blanks are carried along by it between gradually narrowing guides until the foremost is stopped by the catch *G*, and waits its turn to be carried along by the feeding jaws *H*. The four punches, it will be noticed, move up and down together, the two cranks being in line, and each operating a slide which carries two of the punches. The function of the feeding jaws *H*, then, is, while the punches are up, to clasp at once the new blank waiting at the catch *G* and each piece which has just been operated upon by its punch, to move the five pieces each along a distance equal to the distance between the centers of the punches, to leave them there and get back ready to repeat the operation for the next stroke, and so on. The jaws *H*, which are long flat plates, with five pairs of V notches on their edges opposite each other, are opened and closed by the cam *A* on the main shaft between the cranks. This operates a vertical lever at the back of the machine which moves the back jaw forward and backward, and the front jaw is moved at the same time in the opposite direction, a lever standing upward on the rocking shaft which operates the back jaw being connected to a lever standing downward on the rocking shaft *K* which moves the front jaw, and thus producing the reverse movement required. These rocking shafts are splined to accommodate the longitudinal movement of the jaws, which is produced by the large cam *B* at the left hand end of the crank shaft and the vertical lever *E*. The lower end of this lever connects to a cross-head which attaches to levers *C*, on each of the rocking shafts, and moves them together transversely of the machine. The catch *G* is held in position by a spring, which allows it to swing to let the blank pass after it is seized by the jaws.

While the machine was specially designed for the production of the article shown, it is of course also adapted for turning out with speed and accuracy such articles as stove trimmings, screw tops, lantern parts and other articles made in

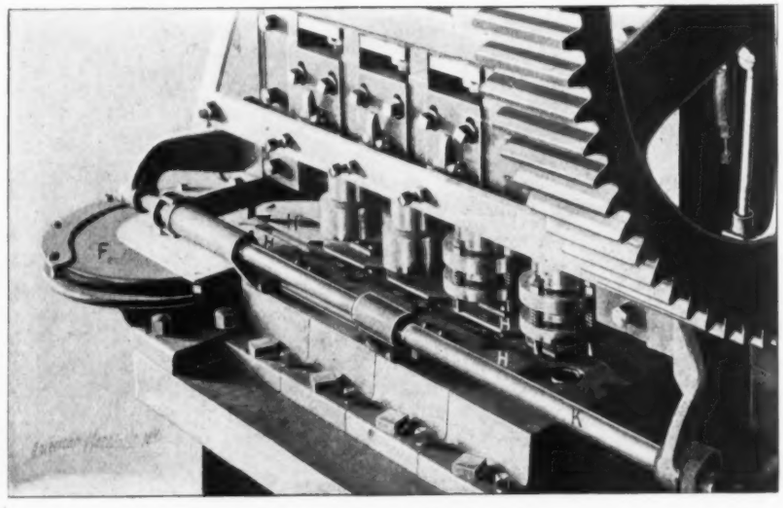

FIG. 3—FEEDING MECHANISM.

large quantities which require a series of operations after the first cup or shell has been made in a combination or drawing die. Its work is the equivalent of ten to fifteen old style hand fed presses, the saving thus accomplished both in labor and in space required being very striking. The machine, by the way, is made for a foreign order, the demand from abroad at present being especially for automatic features in machinery. The weight of the machine as shown is 4,000 pounds, the pulleys are 20x4 and the ratio of the gearing is 6 to 1. The motion of the slides is 3½ inches and the floor space required for the machine is 55x72 inches. It is built by the E. W. Bliss Company, Brooklyn, N. Y.

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Shop Tools Driven by Compressed Air—IV. The Pneumatic Jack.

The stimulating influence of our patent system is perhaps nowhere more emphatically evidenced than in a conspicuous case where that influence is inoperative. It happens that the apparatus usually employed in the various useful applications of compressed air are unpatentable. The action of compressed air is so similar to that of steam, and the uses of steam have been so completely exploited, that there is no chance for any master patents upon which the control of a system could be founded, or, ap parently, a secure hold of a permanent business of manufacture be maintained. As a consequence compressed air has not secured any interested advocates to push its general interests, and so far as it has found recognition and employment it has been upon its merits alone. Rock drills happened to be a distinctly patentable invention, and consequently one or two wonderfully successful businesses have developed in that line. The pneumatic hammer is closely allied to the rock drill, and is developing under similar business conditions. The manufacture of other apparatus employing compressed air has not been pushed in the same way, simply because there has been little prospect of controlling a permanent business.

The case of the air hoist may perhaps be cited in controversion of the above remarks. The direct acting hoist is the peculiar and special creature of compressed air. Many shops adopt a compressed air plant for the sake at first of it alone. There are several manufacturers of air hoists who, it is to be presumed, are doing a prosperous business on account of the extensive demand for such hoists and of the employment of judicious advertising arrangements; but it still happens that air hoists are quite frequently of home manufacture in the shops where they are used. Many railroad master mechanics find it quite easy to build what it would be almost impossible for them to buy, and in many of their shops the home made hoists are to be found. It remains true, even for as simple a thing as the air hoist, that some are better than others, and the best may be expected to be the product of the most concentrated design and experience, and this of course is to be found where the air hoist has become an established specialty of manufacture.

The wide variety of other apparatus which compressed air animates is as yet almost entirely of a home made and provisional character. It is almost invariably the case that the apparatus works all right, but needs some licking into shape before it should be considered adapted to permanent establishment. Probably the most frequent fault is in making such apparatus, which is often of a portable character, unnecessarily heavy and clumsy. Metal which is not needed for strength or wear is much more than wasted if it is to be frequently handled.

Attention is called to the accompanying sketches of an air jack, which should be a handy tool in many shops. Its general and ready usefulness and the familiarity with which it may be handled and

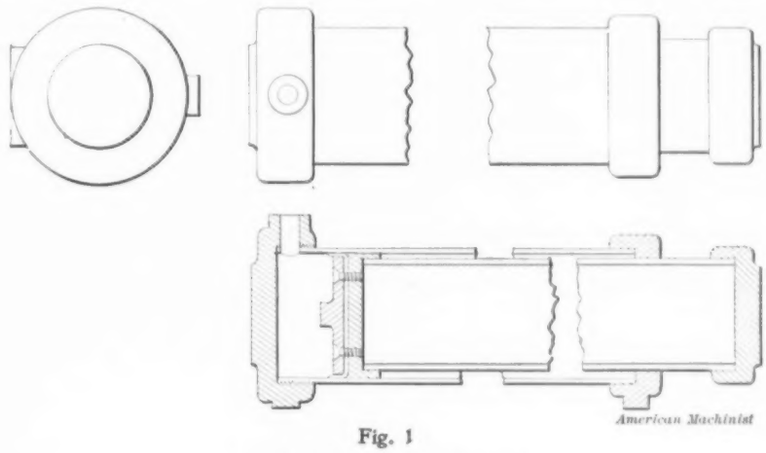

Fig. 1

A PLAIN PNEUMATIC JACK.

operated by anybody, entitles it to the name Jack. Its actual work is the same as that of the hydraulic jack, but it is not so clumsy, is much quicker in action, can work in many places where the hydraulic jack cannot be used, as it requires no room to work the handle, and its operation does not entail the employment of human muscle, the use of which is getting quite out of fashion in the shops, as elsewhere. As will be seen in Fig. 1, this device is about as simple as could well be imagined, and any machinist could make it. The size kept in mind in making the sketches was 5 inches for the bore of the cylinder and, say, 4 feet long, although the dimensions might be whatever the special circumstances of use suggested. If the bore was 6 inches the jack might then be called a one-ton jack, with the usual air pressure of not less than 75 pounds gage. The cylinder may be of 5-inch wrought iron or steel pipe, nicely bored and screwed into the base with an air-tight joint. Better than the iron pipe would be a seamless brass tube. The outside of the pipe at the other end should be true with the bore, as the cap serves as a guide for the inner tube. This cap may be shrunk, pressed or driven on with two or three pins or rivets to hold it. Both the base and cap have a bearing piece on the side for supporting the jack when used horizontally. It might be proper to have a similar piece also on the cap of the inner tube, so that when the jack is extended it will not sag. Neither piece on this tube requires to be screwed on, and no air-tight joint is required. A piece of 4-inch iron pipe would be suitable for it, turned on the outside to, say, 4⅜ inches diameter, and if it is smooth and true, so that it will work nicely in the cap of the outer pipe, it will not matter if there are a few seams and flaws in the finished surface. A cup leather packing might be used as shown for the lower end. The projection in the center of the plate will prevent the lip of the leather from striking the base when the ram is clear in. A ⅜-inch pipe connection and valve is plenty large enough, although the relative proportions of the sketch suggest ½-inch. A common three way cock may be used, and if so the port holes in the plug might have a sharp V notch filed in the edge to allow for slow admission or discharge if required. A tee with two globe valves, one for admission and one for discharge, does not look as neat as the three way cock, but is a very good arrangement. Both valves should be placed to have the pressure under them, and they can, of course, if operated carefully, guarantee as slow an opening as may be desired. No handles are suggested on the sketch, but they may be provided according to taste. As the jack must usually be handled by two men, one at each end, no handles are really required.

Fig. 2, although it looks quite different, is practically the same jack as in Fig. 1, with the addition of the rods and eyes which make it a pulling or hoisting jack.

The lifting or thrusting jack is in itself changed in no way except that the castings are made with the eyes at the corners for the bolts, and without the rods it may be used for any thrusting service or for any lifting from beneath the object. With the same air pressure the thrust or the pull will of course be the same. If used as a hoist the jack should be suspended with the base or left hand end downward. The hight required above the load will be greater than with the usual piston and rod style of hoist, but the arrangement is not otherwise objectionable. There is no stuffing box to leak and to require looking after, the only packing being the cup leather of the piston.

It is not necessary to say anything of the uses to which the jack may be put. It is especially handy for moving machinery or heavy weights around, or for many places in heavy erecting. If a gage is provided it is always possible to know by it precisely what force is being exerted. If used vertically for lifting, either from above or from beneath, it tells quite closely the weight of the piece lifted. The piston area multiplied by the pounds of pressure give the total force, and one-half the difference in gage pressure between hoisting and lowering must give very nearly the friction loss, to be in one case added and in the other case deducted. The jack must not be used against a resistance which is likely to terminate suddenly, as in such a case the ram would fly out of the cylinder like a shot.

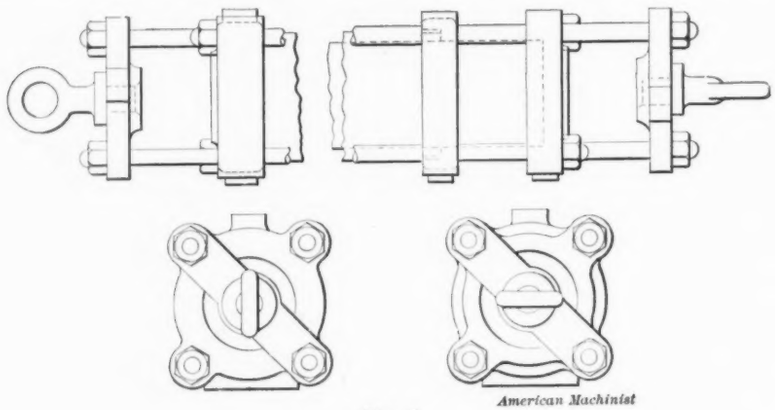

Fig. 2

A PUSH AND PULL JACK.

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The Best Shop Schooling.

During the past few years I have met and conversed with a large number of men of high position in engineering establishments, and find as a whole a great inclination on their part to be bigoted and partial in declaring the relative educational advantages of different concerns or branches of work.

One of these, in a moment of enthusiasm, went so far as to make a statement that a man could not have had a "finished" idea of business if he had not been employed in P's shop or in Q's.

When I speak of shop I mean that part of it where pencil and paper are the tools.

It is also apparent that the majority single out two or three concerns that have a duly earned high reputation and quote these as models, purely from the aforesaid reputation, as on careful notice of further conversation it was noted that several admitted that these very places had never been honored with their presence.

We all realize that for a young engineer or draftsman the better the shop the better for him, but the question arises what is "best?" Can any one place be called better than all others? In this age of specialism can a man experienced and educated in this "best" shop be equally expert in another doing an entirely different line of work?

Shop practice and drawing-room methods vary greatly, as we all know. In some there is a system elaborated to an almost maddening degree, in others the lack of any pretense to system is enough to ruin the future of any man engaged there; but where is genius born? Not likely in a place where every detail of management has been worked out and put into operation. The want of a thing generally starts the brain to conceive of a way to supply this want, and in this is the defense of the man brought up in the "not best" shop.

If all the assertions which I have heard were true the only good machinery in existence would be built in works where there were big drawing-rooms (of course, and big shops), where elaborate drawing cabinets were in use and where a couple of hours' work was put on every tracing to gratify the head draftsman's ideas of system. I won't attempt to describe the recording done during the shop work.

This is nice and in moderation believed in by any man of reason, but to state that a man is not well schooled unless he has been in such a place (generally narrowing it down to two or three) is bosh. Suppose a man has spent several years in a locomotive works. He makes a change and goes to a large press manufacturer. "Where have you been?" the manufacturer asks. "In So & So's locomotive works," is the reply. Will that carry any weight in his application for engagement here? Yet he has been "brought up" in one of these "best" shops.

Some people are born systematizers. They will use system in their own individual work whether there is any in force around them or not. If they are unfortunate to be where there is none their natures enable them to see where it is lacking or what ought to be.

Others have none, couldn't have any pounded into their heads, couldn't be forced to follow a system under penalty of death. It has been my luck to run across some of these. They get orders to letter a drawing (for instance) in a certain corner, in a certain manner, and "blow me" if they won't change it just a little bit. Why? No one knows, not even themselves. The only excuse is that they cannot maintain constancy, even though we might say that it was due to "originality in thought." (This was an excuse once given for habitual violation of rules of work.)

When the question of design comes in then it is well to be where the designs are up to date. Until a very few years ago some large concerns were turning out work with the frames full of panels, beads, ogees, etc., like a coffin. This was rectified, not by getting new talent, but by spending money and allowing to the help they had the freedom of changing these old designs.

Many have spoken to me of the fine systems in use in the shops they "came from." This can be taken in two ways—either that they do not know what "good" is, or that it really was worth mentioning. Some places that were spoken of are not on my list as models.

The conclusions can be drawn as follows: There are no "best" shops. A man experienced in a poorer one is just as expert as if from the other kind, provided he himself is one of the "best" and looks at the outside world in addition to that under his own shop roof. In each special line of work there may be one who is considered better than the others, but invariably when a smaller concern grows to be a dangerous rival of the "best" it is on entirely different lines of design and shop management worked up by some fellow who has better brains than eyes and ears to copy from others.

In judging graduates of schools or of shops more depends upon the graduate than upon the character of the school or shop he came from.

CISNARF.

An Example of English.

An English contemporary quotes the result of an attempt on the part of a German manufacturer to follow good advice in regard to printing circulars, etc., in the language of the country to which they are sent.

"We pique ourselves," says the circular, "on making you known that the sale of the —— has, by us, undertaken. This preparated, exclusively arranged by some vegetables, is entirely spoiled about something hurtful to the steam boiler blades. By our preparated every calcarious substance is neutralized, reducing it to power, and at the same time steam boiler blades are conserved from the usual *corrosion*, not only, but the *ebullition*, is totally avoided, as it appears about some very interesting experiments, which have been made in several establishments." In conclusion, the circular adds, "To be willing, this preparated may be decomposed."

This, of course, is ridiculous, but not more so than some of the efforts of those whose language is English to get up circulars in other languages.

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Three Modifications of the Geneva Stop.

The accompanying engravings illustrate three highly ingenious and extremely interesting modifications of the device used in watches to prevent over winding which have been recently applied by Mr. Hugo Bilgram to various automatic machines constructed at his works. The constructions have a family resemblance in principle, though they are entirely unlike from a structural standpoint.

Three main features characterize the constructions: first, the intermittent motion of the Geneva stop; second, the entire absence of shock at engagement or disengagement, and, third, the positive character of the movement—the parts being locked in position both when they are in motion and when they are idle.

Fig. 1 represents the smallest departure from the watch mechanism. The interrupted disk *a* is the driver and revolves continually. The driven piece is seen at *b*, and the requirements are that the driven piece shall remain at rest during three-fourths of a revolution of the driver, and shall then make one-quarter of a turn during the remaining quarter turn of the driver. The driver may revolve in either direction, but supposing it to turn in the direction of the arrow, a roller *c* attached to the driver is about to enter one of four radial slots in the face of the driven piece. During the succeeding quarter turn of the driver the parts will move together, the motion of the follower ceasing when groove *d* has reached the position occupied in the figure by groove *e*, and this movement of the follower will obviously occupy ninety degrees of angle. It will be seen that the parts are so laid out that roller *c* enters and leaves the grooves tangentially, insuring absence of shock at both the commencement and the conclusion of the engagement.

At *f g h i* on the follower is a series of rollers raised above the faces surrounding the grooves, and the circular part of the driving disk carries a circular groove *j k l* at such a radial distance as to engage these rollers in succession during the idle period of the follower and hence lock it in position. It is obvious that in the direction of motion supposed, this circular groove is just leaving roller *i*, and so disengaging it preparatory to movement by roller *c*. On the completion of the follower's movement, roller *f* will occupy the position of roller *g* in the illustration, while the end *l* of groove *j k l* will have turned to a position ready to embrace it and so lock the follower in position. With motion in the opposite direction, groove *j k l* in the position shown would be in the act of engaging roller *i* on the completion of the movement. Rollers *g* and *i* being at the same same distance from the center *m* of the driver, both are engaged by the groove during a revolution, the locking taking place with one and the unlocking with the other, both rollers being in the groove during most of the time.

A modification of this gear which it is unnecessary to show has five grooves in the driven wheel with corresponding modifications in the character of the movement.

In the second construction the motion of the follower is intermittent like the last, but with different relations between the idle and acting periods. The driver runs continuously, the relationship being:

During 5-6 turn of the driver the follower is at rest.

During 1 1-6 turn of the driver the follower makes one complete turn.

In other words the follower makes one turn to every two turns of the driver, but this revolution of the follower occupies a little more than a turn of the driver.

In Fig. 2 the upper gear is the driver and is complete. The lower one is the follower and has five teeth cut out, and

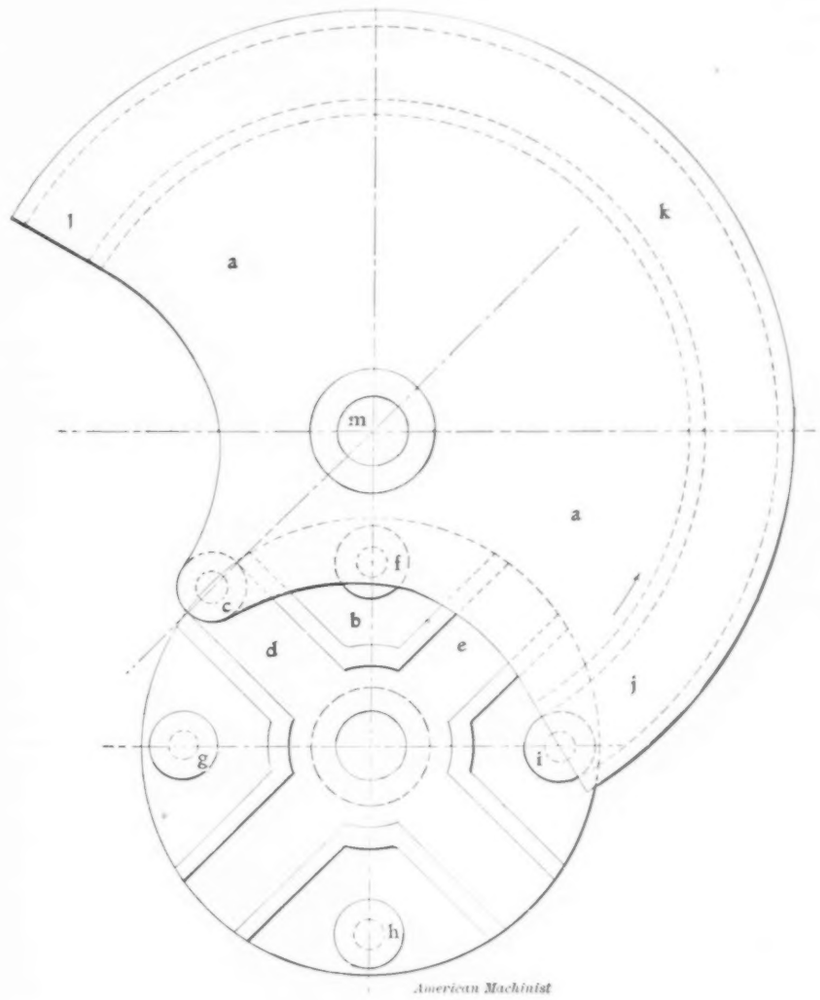

Fig. 1

GENEVA STOP—MODIFICATION NO. 1.

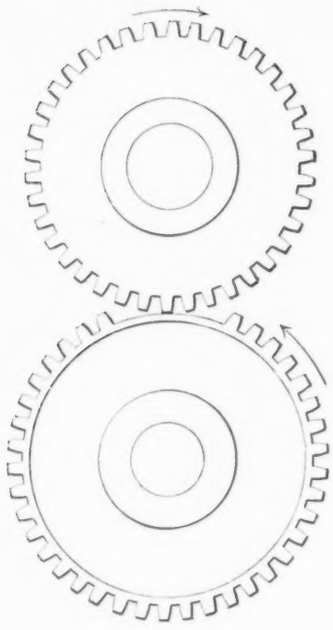

Fig. 2

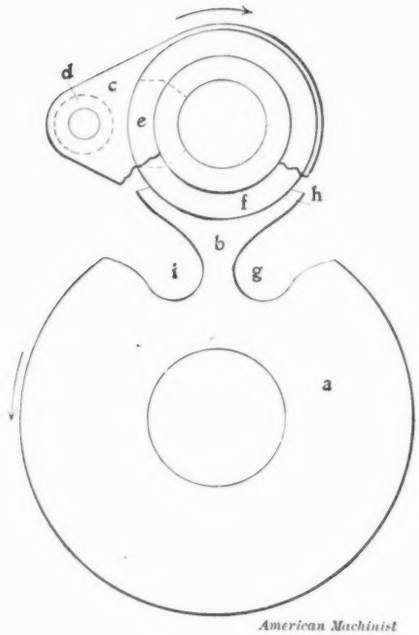

Fig. 3

in the position shown the driver would obviously run on indefinitely without imparting motion to the follower. Pinned to the face of the driven gear is the plate *a*, Fig. 3, the arm *b* of which is fitted to embrace a hub *f* on the driver shaft, whereby, until released, the follower is locked in its idle position. Revolving with this hub is an arm *c* carrying a roller *d*, which is fitted to engage the slot *g*. As it does so, the notch *e* in hub *f* comes opposite finger *h*, thus disengaging the locking mechanism. Roller *d* enters tangentially without shock and accelerates the motion of the follower until the roller reaches the line of centers, when the gears engage and the motion goes on. The completion of the revolution of the driver finds the roller *d* again on the line of centers, but engaging slot *i*, and the continuance of the motion brings the parts again to the positions shown. It should be noted that in this mechanism not only is the starting and stopping of the driver without shock, but at the in-

GENEVA STOP—MODIFICATION NO 2.

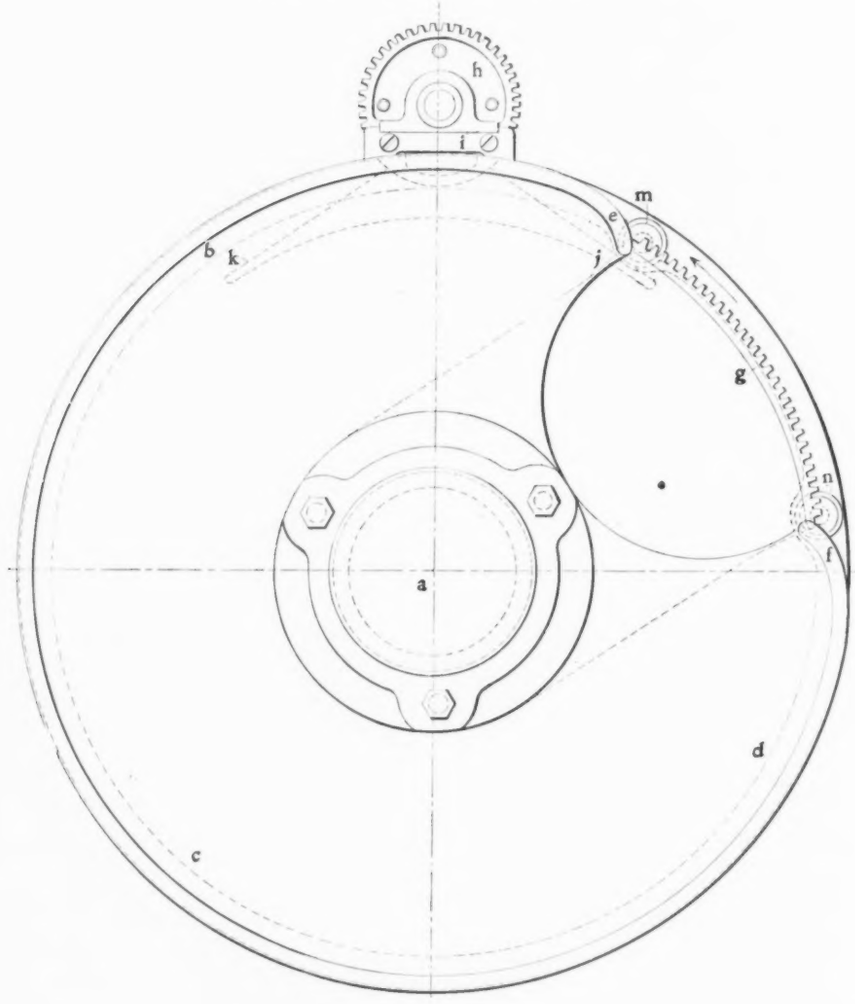

Fig. 4

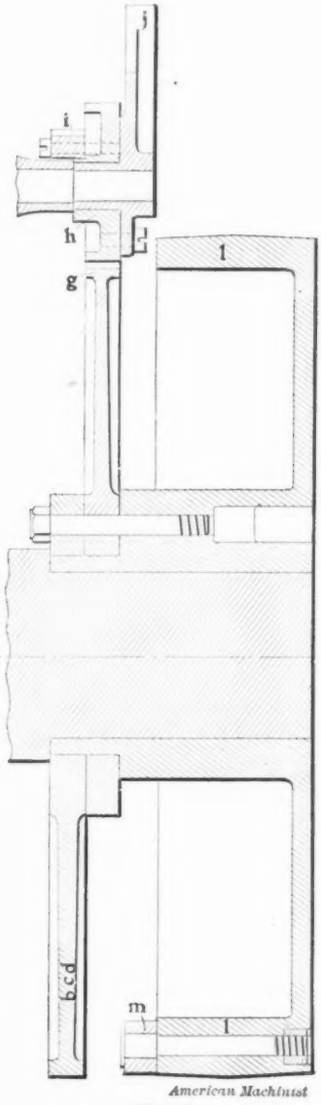

Fig. 5

GENEVA STOP—MODIFICATION NO. .

stant of engagement of the gear teeth the roller *d* has brought the velocity of the follower up to that due to the gears, so that the transition of the motion from the pin to the gears and back again from the gears to the pin is also without shock.

The most elaborate of these mechanisms is that shown in Figs. 4, 5, 6 and 7. In this the driver—turning about *a*—is required to turn through about 73 per cent. of a revolution, while the follower stands still, the follower then making a complete revolution during the remaining 27 per cent. of the revolution of the driver. Figs. 4, 6 and 7 are side views intended to show the action in a succession of positions, while Fig. 5 is a section and shows the construction more clearly. Fig. 5 does not, however, show the parts in any of the positions of the other figures, the follower in Fig. 5 being shown as though turned half over from the position of Fig. 4, with the gears *g* and *h* in mesh, as will presently appear, while rollers *m n* are shown out of place in Fig. 5 in order to bring them in the plane of the section where their construction can be shown.

The driver is an interrupted disk *b c d*, Figs. 4 and 5, having cam-shaped edges *e f* at the mouth of the notch. Slightly in the rear of this disk is a toothed sector *g*. The incomplete driven gear *h* meshes with *g* during the acting periods, and the purpose of the remainder of the mechanism is to start *b* in motion and throw the teeth in mesh as well as to lock the follower in position during the period that it stands still. Fig. 4 shows the parts in position at the beginning of the movement of the follower, which is still locked in the position which it occupies during its idle period. A bar *i* on the front face of gear *h* rides on, and up to this point has been locked in the idle position by the disk *b c d*. Finger *j*—one of a pair *j k*—is attached to the rear of gear *h*, where it may turn freely between the sector *g* and the driving pulley *l*; see Fig. 5. This pulley *l* carries two rollers *m n* arranged to engage the fingers *j k* respectively. In the position of Fig. 4 the driving disk, moving in the direction of the arrow, has brought roller *m* into position, where it is about to engage finger *j*, the direction of the acting side of *j* being tangential to the motion of *m*, so that the movement begins without shock. To permit *j*, *b* and *i* to turn, the edge *e* of the disk is dressed off, but to such a degree that contact is maintained between the right-hand end of *i* and the edge of the disk as the follower turns, so that the motion is positive without slack. As the movement progresses the speed of the follower increases until the position of Fig. 6 is reached when—the roller being on the pitch circle of sector *g*—the speed of the follower is the same as hat due to the gears and the teeth drop into mesh without shock. From this on the gears drive and the arms *j k* turn completely over, the position when the gears go out of mesh being shown in Fig. 7. From this on the action is the reverse of that shown by Figs. 4 and 6, the driving piece being now the cam shaped edge *f* of the disk, the finger *k* preserving the positiveness of the motion and preventing the driven pieces overrunning by momentum as they are brought to rest, the final stopping being accomplished as the roller slips out of action in a tangential direction, and again without shock. From the position of Fig. 7 to that of Fig. 4 the bar *i* simply rides on the edge of the driver disk and the follower remains at rest.

It should be remembered that these mechanisms are not models designed to embody a pretty movement invented beforehand, but they are parts of machines, some of which are made in considerable numbers, and have been devised, as occasion arose, to accomplish certain required results. As such, they represent the art of invention carried to a high degree of perfection. They are but a few of many equally ingenious movements to be seen at Mr. Bilgram's shop, but they fairly represent the character of the work in which he is constantly engaged. Automatic machines for a great variety of purposes are brought to him for construction. In many cases these are mere schemes, of which the method of operation on the work to be done is alone determined, the means of accomplishing the movements and the "whipping into shape" of the whole machine devolving on Mr. Bilgram. It is in the pursuit of work of this kind that the mechanisms here shown have been devised. Our readers do not need to be told that successful work of this kind involves mechanical talent of a high order.

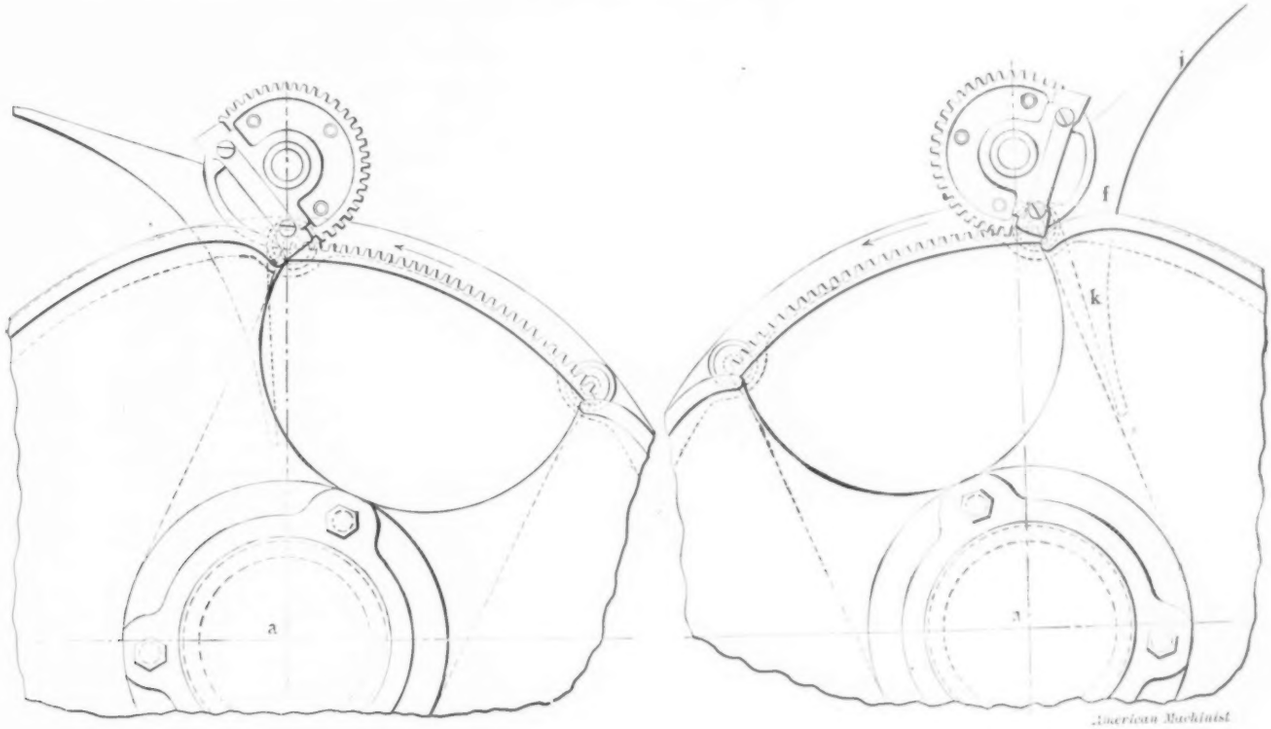

Fig. 6 Fig. 7

GENEVA STOP—MODIFICATION NO. 8.

Piston Packing Rings.

BY W. H. WAKEMAN.

One day a man came into my engine-room and announced that he was the agent for a new and improved packing ring that was much superior to anything before known to the engineering world. Now, sometimes these agents prove to be a great nuisance, but on the other hand they are often very useful, for without them we should miss much valuable information, especially along mechanical lines. They travel from one part of the country to another gathering seed and sowing it also for the benefit of all concerned. Let us always greet the traveling salesman or agent with pleasure, giving him, if possible, all the attention he requires, and, if lack of time will not permit, we can at least respectfully excuse ourselves without giving offense, for such men understand the situation and are willing to govern themselves accordingly.

Returning to the agent already mentioned, I would say that the packing ring or rings that he was advocating were made with a beveled edge on the side toward the steam pressure, while the opposite edge was flat where it came into contact with the bull ring. About the first question I asked him was whether his ring was "steam set" or "spring set?" He said that it was set out by the steam pressure. Upon my suggestion that such rings would wear a cylinder larger at the ends than in the middle, I was met with the somewhat astonishing statement that such was not the case, for although it was admitted that in the case of automatic engines the presure is much greater at the beginning of the stroke than at the end of it, still these rings were so made that a high pressure of steam would set them out no more than a low pressure would. It was impossible to claim that they were balanced. Therefore it was plain that although his rings were somewhat elastic, his argument was about 100 per cent. more so, and, in short, was worthy of being awarded a gold medal in recognition of this quality, which it possessed in unlimited quantities. Furthermore, he claimed that although it was better to rebore a cylinder that had been in use for many years, still it was not absolutely necessary, as his rings would soon level down the rough spots and make the diameter the same throughout the entire length. These rings were equal to any in the market, and gave good service wherever used, but it was useless to make promises for them that no ring could fulfill.

There is at least one engine in the market which had but one narrow ring made in one piece and sprung into a groove in the middle of the bull ring. This has proved so unsatisfactory that it may have been abandoned, for, while it was a simple arrangement, the ring would chatter so as to make it impossible for the engineer to take any comfort. The worst fault with such a ring is that on account of its narrow face it is necessary to make the counterbores deep, so that the ring will travel over, and this makes it impossible to put in a wider ring unless the cylinder is rebored and made as large as the counterbores were. It would, of course, be possible to put in a wide ring, but at the ends of the stroke so much of the outer surface would be exposed to the steam pressure that it would collapse and make a bad pound, unless very stiff springs were put under it, and springs always add to the friction of an engine and cause a rapid wear. The Dunbar rings seem to have lost some of their popularity, although the reason is not plain, for they do good service under fair conditions. One advantage they possess is that it is not convenient for the engineer to set out the springs to cause unnecessary wear and friction.

Any form of ring that is fitted with set screws to stiffen the springs is objectionable, because if the engineer is not very careful he will set them out more than is necessary and cause trouble, not only by adding to the friction, but by reducing the effective power of the engine, which may be overloaded already. Rings that are held in place by flat springs about 4 inches long answer a very good purpose, for as the springs are usually not very heavy they do not exert too much pressure, and a careless engineer cannot do much injury with them.

Engineers usually consider that when a cylinder is new there is great danger of scoring it unless a large quantity of oil is used, but it is really very seldom that a new cylinder is scored. When rings are worn slightly, so as to make them a perfect fit, there is then danger of scoring, for sharp edges will be found upon the rings that scrape the oil completely from the cylinder walls, and this is what causes the trouble. These edges should be removed with a fine file. The water pistons of many of our small pumps are fitted with fibrous rings that are set out by what might be called circular wedges that are forced back by nuts on the piston rods, thus making it possible to bring great stress to bear on the rings, forcing them out so hard in some cases that the steam pressure is barely sufficient to work the pumps, and yet it seems to be a mystery in some quarters concerning the enormous quantities of steam called for by our direct acting steam boiler feeders.

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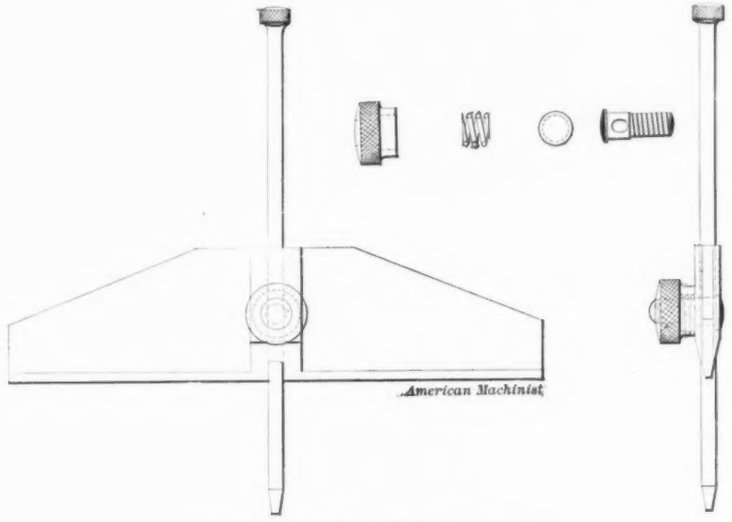
A Quick Adjusting Depth Gage.

The cut shows a handy adjustable depth gage for die sinkers, tool makers and other metal workers. The beam has a plain hole through which the rod, which is threaded its entire length, slides freely. The thread which this rod engages is in one-half of the oblong hole in the little cross-bolt. When the knurled nut is screwed up the thread in the bolt engages the thread of the rod, the minute final adjustment being made by turning the rod itself, which is threaded 48 to the inch. When adjusted the nut may be tightened to hold the rod securely. Upon slacking the nut one-half turn the push spring in the pocket within it still holds the bolt in place, but upon pressing the nut the bolt is pushed back enough to release the threads and the rod may be slid in or out as desired. The beam is 4 inches long and is narrowed to a thin bearing edge. The rod easily gages to a depth of 2½ inches. To say nothing of the relief which this gage affords from a tedious operation necessary by the common construction, it also saves much of the wear upon the screw and nut, occasioned by the fact that depths differing very much from each other must often be gaged successively. The gage is made by the Billings & Spencer Company, Hartford, Conn.



A QUICK ADJUSTING DEPTH GAGE.

The Cost of Fuel Gas.

BY E. P. REICHHELM.

Outside of the natural gas regions fuel gas is not so generally used for mechanical heating as that misconceptions should not exist respecting its value as fuel, and in daily experience we have frequently found that propositions which appear to be self-evident must be repeatedly and clearly explained to men who in their own special vocation are pre-eminent, but to whom this subject has been foreign up to the moment when gas heating has been brought to their special notice.

A recent experience with a manufacturer who has brought his own line of production up to the very highest standard is a case in point. He told me that he had "about concluded to put in a producer gas plant, as the gas could be made at a cost of only about 10 cents per thousand, and that at that rate he knew he could advantageously use it." I told him in reply that I knew of the production of producer gas at less than 10 cents, and had seen it made and put into a holder at a cost only slightly exceeding 7 cents per thousand, but that I did not believe that for his particular work either 10 cent or 7 cent gas would be cheap. Asked for an explanation of this statement, I answered that the cost of 1,000 feet of gas means nothing unless the amount of heat obtainable from it is known. Since 140,000 heat units per 1,000 feet was a liberal estimate of the caloric efficiency of producer gas, the cost of 1,000 feet of such gas would have to be multiplied by five in order to get at its true cost as compared with city gas, which contains nearly 700,000 heat units per 1,000 cubic feet. Hence 7 cent producer gas would cost 35 cents as compared with illuminating gas, and 10 cent gas would cost 50 cents.

This, however, is not the whole story. Producer gas cannot be used in small space. It is bulky and will not readily mix with air, and its distribution is difficult because of the small proportion of air which can be injected into the heating chamber with it, so that while useful in large space, either with natural draft or under a very low air pressure, it cannot be made to work in gas blast furnaces, which are admittedly superior to all other heating devices for general manufacturing uses, except in very large furnaces used in rolling mills or iron and steel works, where furnaces are kept in continuous operation.

A previous article published in the "American Machinist" under the head of the "Relative Value of Different Fuels" [January 10, 1895,] contained a tabulated statement of the heating value of different gases in common use, as also that of coal and crude oil, the substantial correctness of which has been verified by ample experience since then.

It omitted, however, to give a simple rule or formula by means of which anyone not especially versed in gas matters could readily figure the true cost of different gases, and would not be liable to be deceived into believing a 7 cent or 10 cent gas cheap. The number of heat units contained in any gas is of course the measure of its efficiency. A certain number of heat units are supposed to be contained in each kind of gas now in common use, which have been ascertained by repeated analysis and common experience in daily practice, and taking the commonly accepted number of heat units contained in each gas as a basis we have a means of comparing their heating qualities without much trouble.

Take 1,000,000 heat units as a result to be obtained, divide this number of heat units by the number contained in 1,000 feet of each kind of gas; then multiply the quotient by the price of the gas and you have the cost of 1,000,000 heat units in each case.

For instance, the ordinary illuminating or city gas contains 675,000 heat units per 1,000 feet and costs $1.15 in the city of New York.

The producer gas above referred to contains 140,000 heat units per 1,000 feet and in medium sized plants will cost 10 cents per thousand. Naphtha gas made by the American Oil Gas Machine contains 2½ gallons of naphtha per thousand feet with 306,000 heat units, and at 6 cents per gallon for naphtha this gas would cost 15 cents per 1,000 feet, and proceeding according to the foregoing rule the following tabulated statement would result:

	H. U. Wanted.	H. U. in 1,000 feet.	Quotient	Price per 1,000 feet.	Cost of 1,000,000 H. U.
City gas.....	1,000,000 ÷	675,000 =	1.48	$1.15	$1.60
Producer gas.	1,000,000 ÷	140,000 =	7.1	.10	.71
Naphtha gas..	1,000,000 ÷	306,000 =	3.2	.15	.48

The number of heat units in a gas is not, however, the only feature to be considered, but also the nature of the work to be done. As a general thing, gases rich in carbon must be preferred for fine metal work, and oil gas is undoubtedly the best for such work. Gas made from coal contains traces of sulphur or sulphuric acid, which produces scale by corrosion. This is not noticeable in forgings, but in annealing or hardening almost all finished work will show it clearly. To anneal wire for the last draft a pure atmosphere in the oven surcharged with carbon is particularly desirable, and a pure hydrocarbon gas, even at a higher price, would pay better than any retorted gas.

New York.

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It is said that a New England firm paid an inventor $100,000 cash for an improvement in shoe manufacture, and then gave him $2,500 per year for life upon the condition that he should invent no more.

Organization Meeting of American Section International Association for Testing Materials.

PHILADELPHIA, Pa., June 16, 1898.

The meeting was called to order at 7:45 P. M. by Mr. Gus. C. Henning, of the membership committee, who explained in an exhaustive manner the aims and objects of the Association and the problems which are before it for consideration. He explained the necessity for organizing the American Section, and pointed out that the American membership would receive much more consideration as such than as independent members.

The following officers were then elected:

Chairman, Prof. Mansfield Merriman, South Bethlehem, Pa.

Vice-chairman, Prof. Henry M. Howe, New York.

Treasurer, Paul Krenzpointner, Altoona, Pa.

Secretary, R. L. Humphrey, Philadelphia, Pa.

These officers, with Mr. Gus. C. Henning, ex-officio, are to constitute the executive committee, to which was delegated the duty of proposing by-laws, as well as nomination of members of subcommissions.

This executive committee was to report to the American Section at a meeting to be held between the middle and end of August, 1898.

It was decided that the Section was to have one meeting a year, unless important work made it seem desirable to meet oftener.

Two confidential councillors, to represent the Section at all council meetings, were also elected—namely, Prof. Henry M. Howe and Dr. R. G. G. Moldenke.

Problems to be studied by the Association:

The Sidero Chemical Laboratory.

On the supervising commission to manage the laboratory, Prof. Henry M. Howe, of the Columbia University, of New York, was appointed.

Problem 2. "Ways and means are to be sought to establish international standard specifications for the inspection of all kinds of iron and steel, on the basis of those already existing."

The American Section shall appoint two members on the sub-commission taking up this subject.

Problem 3. "Determination of methods of tests of the homogeneity of iron and steel, looking to their eventual use in inspection." Six members.

Problem 4. "Preparation of uniform methods of tests of paints as protection against corrosion of railroad structures. Four members.

Problem 5. "Unification of tests of terra-cotta pipes." A sub-commission of seven members, one from American Section, is to take up this subject.

Problem 6. "Standard consisting of standard mortars. Determination of conditions which will produce approximately similar density of tension and compression briquettes." Four American members.

Problem 7. "Investigation of behavior of iron under abnormally low temperatures."

Problem 8. "Methods of testing welds and weldability."

Problem 9. "Collection of all information for preparation of standards for 'Piece Tests,' with special reference to axles, tires, car springs, cast and wrought pipes, as well as of separate parts of structures."

Problem 10. "Investigation of the most practicable methods of polishing and etching for micrographic study of wrought iron."

Problems 11 and 12. (*a*) "Study of the relation of chemical compositions and weathering qualities of building stones. Study of effect of gases of combustion, especially of sulphurous acid."

(*b*) "Method of determining the weathering qualities or properties of slate."

Problem 14. "Determination of rapid methods for determining conditions of constancy of volume of hydraulic bond materials."

Problem 15. "How can hydraulic bond materials be tested rapidly for their strength?"

Problem 16. "Study of resolutions of conferences relating to the determination of adhesive strength of hydraulic bond materials."

Problem 18. "Investigation of causes of abnormal behavior of cements as to time of setting."

Problem 19. "Investigation of the effect of fecal matter on the strength of hydraulic bond materials."

Problem 22. "How can inspection of lumber ensure protection against growth of fungi (merulius lacrymans)?"

Problem 23. "Determination of fundamental methods of testing lubricants (oils)."

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Letters from Practical Men.

Spirit Inventions.

Editor American Machinist:

CHESTERFIELD, Ind., June 18.—John Q. Shimer, patentee of the Shimer fence machine, which was sold this week for $100,000, claims to have been assisted by "spirit power" in perfecting his machine. After two years of incessant labor he mastered his patent with the exception of one "point" necessary to complete it, whereupon he attended a spiritual seance at which a spirit message let him into the secret, resulting in the completion of his machine, the success of which is manifest by the demand and the fabulous price paid for it.—Special to the "Indianapolis News."

The above clipping divulges the great secret as to where the vast number of inventions come from that we ordinary every-day mechanics cannot understand.

We call the inventors of such inventions "would-be inventors," and say their inventions are "senseless and worthless." we should beg pardon of all the inventors to whom we have applied these epithets, because these inventions are coming from the spirit land, and are no doubt of very great value there, and in this case it is proven that at least one of the inventions used in the spirit land is of very great value in this land.

It is no disgrace for an inventor to come out boldly and honestly as this man has and state that his inventions are from the spirit land, because it is clearly proven in this case that such inventions are worth a thousand times more than inventions from this land, and the spirit inventions should be given a special number series at the Patent Office, so they could be clearly distinguished from our common inventions. J. H. SNOW & Co.

Indianapolis, Ind.

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A Milling Job—Foreign Made Sewing Machines.

Editor American Machinist:

The "milling job" shown on page 438 of the issue of June 16 has a very familiar look. It is for the same purpose as the Grover & Baker sewing machine looper spiral and driver, and the foreign machine for which it is made is made on the same principle—*i. e.*, it is a modified Grover & Baker machine. Parts like these must have been made twenty-five years ago by the old Grover & Baker Sewing Machine Company, long defunct now. I am familiar with the method of making these pieces and have handled thousands of them, and a short time since we were called upon to devise a rig to do similar work.

There are two methods which can be used. They may be milled flat and twisted hot afterward, as drills and auger bits are, or it can be done as cam cutting is—*i. e.*, make a master spiral and transmit the motion, which it gives to a block, by gearing to the piece to be operated on. This is only a suggestion, but anyone familiar with milling machines and cam cutting will understand. The spiral is so sharp that no ordinary milling machine will do it, and as the straight piece has to be milled also the regular spiral attachment would not do.

I noticed that your correspondent "R" could not refrain from stirring up the eagle and causing him to emit a scream to the effect that some American sewing machines run at over 2,000 revolutions per minute, while the "poorly made" foreign ones cannot be run at over 600 turns per minute. Well, American sewing machines can and do run as fast as 4,000 revolutions per minute, but they are not glove machines, and no machine for that work can run at that speed, or is ever wanted to. Give the devil his due. There are many sewing machines made in Europe for special operations, which are not made here at all, and they are excellent for the purpose intended, even if they are not always 1898 models. There are embroidering machines made in Berlin and Paris which are most beautiful and durable specimens of fine interchangeable sewing machine work, of which the finest shops in America might be proud. R. J. HEARNE.

Secretary and treasurer Durbrow & Hearne M'f'g Co.

New York.

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Pickling Castings.

Editor American Machinist:

Referring to the communication of Mr. Morris Fulton in your issue of May 26 in regard to pickling castings, as I am very much interested in this subject at the present time, and have under consideration the equipment of a sand blast apparatus for the same work, namely, cleaning small castings which have been heretofore pickled, it would certainly be of great interest to me, and perhaps also to a large number of your readers, to have the views of some practical men on this question.

The points to be brought out are as follows: First of all the matter of expense in performing the work, and, secondly, in the comparative excellence of the finished product after being through the pickling process, or when manipulated with the aid of a sand blast apparatus. In dipping castings which are subsequently to be baked in a japanning oven the product is much superior after having been cleaned with the sand blast apparatus to those castings which are pickled; as, from the experience I have had, the pickled casting seems to require more filling and does not produce such a high gloss with one dip as the piece which has been sand blasted. If this appears to be of enough interest to your readers I would be very glad indeed to have the views of experienced mechanics on the subject. OTTO W. SCHAUM.

Philadelphia, Pa.

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The Power of Windmills.

Editor American Machinist:

In your issue of June 2, in the editorial notice of the meeting of the Mechanical Engineers at Niagara Falls, you say: "The winds that blow across the roof of one of our tall office buildings all the year round could be made to yield an average of several horse power." Could you kindly give me some idea of the

actual power to be realized from a respectable windmill?

S. G. CLEAVER.

Buffalo, N. Y.

[The power to be derived from windmills is probably not as great as popularly estimated. From the catalog of a windmill builder of long established reputation we take a single item, which will give us sufficient data for our purpose. When employed for pumping water into a storage tank the windmill is probably at its best, and in a table by the builder referred to a 30-foot wheel, the largest diameter made, is guaranteed to deliver 13,747 gallons per hour against a head of 50 feet. As a gallon weighs, say, 8 1-3 pounds, the foot pounds represented by the above statement are $13{,}747 \times 8\ 1\text{-}3 \times 50 = 5{,}727{,}900$ per hour, or 95,465 per minute, and this, divided by 33,000, gives a little less than three horse power. The average running of the windmill doing this work is but 7½ hours out of the 24; the rest of the time it stands still for lack of sufficient wind, so that the 30-foot wheel cannot be calculated upon to give quite the equivalent of one horse power for every hour of the day and all the year round. On the large office building it would, of course, be possible to place a wheel of considerably larger diameter than here considered, so that our statement could be theoretically substantiated; but it is not likely that any large windmills will soon greet the eye in this city.—ED.]

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Another Centrifugal Pump.

Editor American Machinist:

Referring to Mr. Hugh Hill's article, May 26, about the old gentleman's centrifugal pump, I would like to congratulate the old gentleman on the correctness of his design and the efficiency of the pump. I can assure him that it will give about 90 per cent. of the energy applied to the shaft, where the same pump running in water instead of air gives only 70 per cent. Commercially the pump may never be of great value, but in the hands of proper parties might be developed into a practical machine.

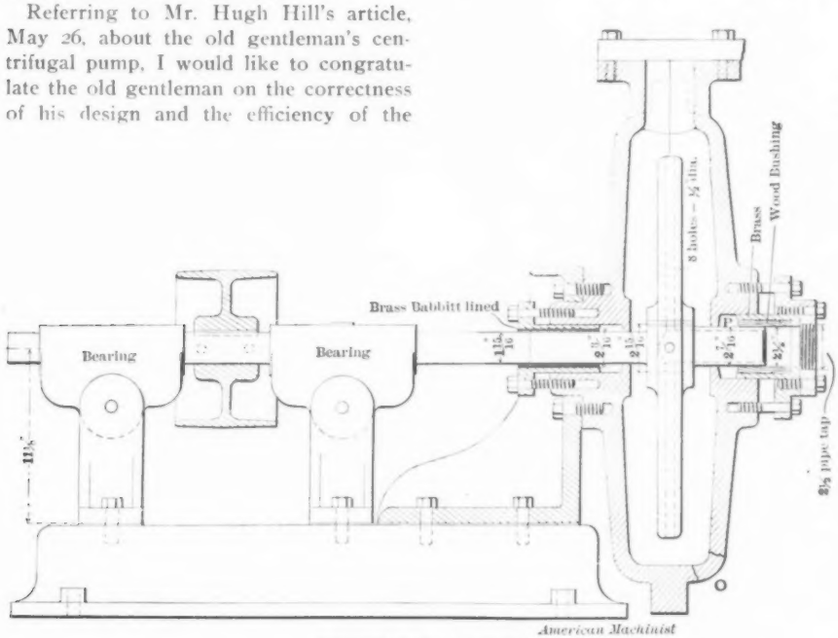
I do not want to claim this invention, as it never occurred to me to erect the pump vertically above the shaft, and this is the only position in which the disk can be kept in air for any length of time. All my experiments were made with our regular horizontal pump, and always gave the same result. The air would escape on account of the leaking of the packing box, the leak being induced first by the burning of the packing. It did not seem possible to pack this joint so that the pump would run any length of time, so I gave it up. The increase of efficiency did not admit of a doubt, however, as we were enabled to make test runs of five hours' duration by adding air with an ordinary bicycle pump to make up the loss. The pumping disk is 2 feet in diameter, turned smooth and drilled with radial holes.

The drawing is now obsolete, as we have changed our patterns, but it shows the exact construction of the pump we used in making the experiments. The discharge was closed by a blank flange, and a 1½-inch outlet was tapped at *O*.

A. H. LEFEBARE,
Supt. Harmon Machine Co.

Watertown, N. Y.

[There is sufficient difference in the two pumps to make them far from identical, so that this, although apparently the earlier one, did not include all the features of that which we previously illustrated. The avoidance of the air leakage is in itself an important feature, and the efficiency which both of our contributors assign to the arrangement would seem to warrant its wider adoption.—ED.]

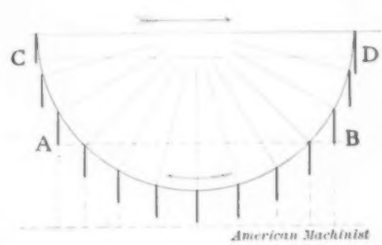


CENTRIFUGAL PUMP.

The Drag of the Feathering Paddle Wheel.

Editor American Machinist:

It is rather late in the day, I suppose, to be discussing the action of the paddle wheel, as is done by Mr. W. H. Booth is your issue of April 14, but the lateness of the day should in itself carry a presumption that the discussion when undertaken would have a completeness somewhat commensurate with the accumulated experience. The point brought out by Mr. Booth is one that it is well to know, and one which many persons have not thought of without some outside suggestion. I can understand that if I spread my hand out flat and strike a surface of water at an angle of, say, 45 degrees, it will make quite a difference, as to the ease with which the tips of my fingers will enter the water, whether both I and the water are stationary or whether we are approaching each other. In the latter case my fingers will enter the water much



easier and the relative angles of motion will be quite different. The same is true and in favor of my hand, or of the radial paddle, when leaving the water.

This, of course, is much to the advantage of the radial wheel. In connection with it, when the avowed purpose of the article was to minimize the disadvantages of the radial wheel, it might have been proper to call attention to the *drag* of the feathering wheel. Many admirers of the ingenuity displayed in the feathering wheel have wondered why it has not been universally adopted upon steamboats, but have not thought of the constantly changing rate of fore and aft travel of the blades, and of their operation to actually retard the progress of the boat if too deeply submerged. The little diagram herewith shows how it is without going into any labored explanation. Even if the wheel was submerged only to the line *A B*, it is evident that the blade just entering the water and the other just leaving it would not have the same rate of linear advance as the central bucket most deeply submerged, and if the wheel was down in the water to the line *C D* the buckets then entering and leaving the water would have to be propelled forward against the water just as much as the hull itself, instead of helping things along, as they should do. This drag of the feathering wheel is a serious objec-

tion to it, and alone is sufficient to account for its neglect.

MORRIS FULTON.

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Truing Milling Cutters — Drilling Records.

Editor American Machinist:

It sometimes happens even in the modern machine shop that a cutter or saw has to be used that has its hole too large for the machine mandrel. If put on without bushing it is likely to play the eccentric and two or three teeth will do all the work. To true it a piece of soft metal is commonly used to strike the high side an indefinite number of times until it runs true. Instead of that, suppose the cutter should be run into the work enough to cut a space equal to three or four teeth, then loosen the binding nut on the mandrel to give a moderate pressure, feed the work up gently against the cutter; as soon as it touches it will slip, and move toward the center, and in this way can be made to run as true as though it fitted the mandrel, and sometimes more so.

With the binding nut set up the cutter is ready for all of the teeth to do their share of the work. I do not claim this as a new scheme, but have never seen anyone use it but myself. It may answer as a hint to some who never had thought of that way of doing it.

Some former articles in the "American Machinist" on speed in drilling reminded me of my own experience. Having to drill some cold rolled steel shafting, not having twist drills suitable, I made a flat drill of tool steel ¼x¾ inch, spreading the end and turning lips to give the twist drill cut; then drilled holes 15 inches deep, 1 1-32 inches diameter, dry, after the first 2 inches, in one case in 59 minutes (would not want to tell a lie for that other minute), which I think about equals the best results given so far under similar circumstances. The average on 50 holes was nearer 75 minutes each, including grinding, reforging drill and rigging up, the lathe running 76 revolutions per minute.

ALL-ROUND MACHINIST.

▲ ▲ ▲

The Sang Generated Gear Tooth.

Editor American Machinist:

The most interesting letter of George B. Grant in your issue of June 2 makes the statement that the one cutter used by the Fellows gear shaper cannot produce a set of interchangeable gears. At least I take it for granted that his remarks are aimed at this system, as it is the only one of the list mentioned that cuts spur gears or that uses a gear as a planing cutter. As it is an established fact that it does do this, perhaps a few words from me will be acceptable.

I quite agree with Mr. Grant when he says that "if a gear is cut with a forming gear of twelve teeth" of the form shown by him, "it will work only with gears having twelve teeth or less." But by reference to that most excellent handbook, "Grant's Treatise on Gearing," Mr. Grant will see that it is stated that all gearing should have a clearance; that is, a space between the end of the tooth and the bottom of the space of the mating gear. It is obvious that in making this cutter we have added to the outside diameter sufficient to produce this clearance. The form of this extra length of cutter tooth is a continuation of the involute curve. This results in a corresponding extension of the base of the involute of the gear tooth, or in case of a pinion of the flank. This is shown in Fig. 1, the tooth *A* being the one that Mr. Grant imagines that we must use, while the shaded portion shows the extension for clearance or, the cutter as we actually do use it. The dotted line *a* indicates the fillet produced by the tooth *A*, while the full line *b* gives the form produced by the extension.

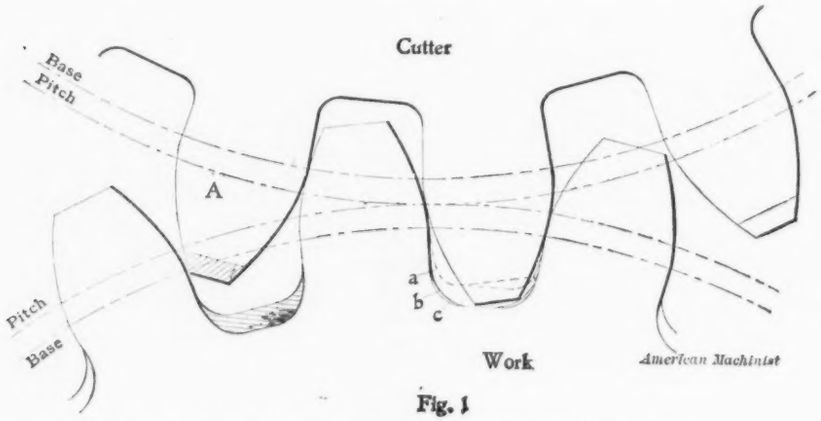


Fig. 1

FELLOWS GEAR TOOTH, SHOWING EXTENSION OF FLANK.

But there is another feature of this system that seems to have entirely escaped Mr. Grant's notice, and that is that in making this cutter we are not tied up to any standard for proportions as long as the work produced by it corresponds to the accepted standards. The cutter can be, within reasonable limits, larger or smaller than the gear of the same number of teeth, provided only that the involute is generated from the same base line. This feature is shown by Fig. 2. In this case the outside diameter of the cutter is reduced from that of the gear an amount equal to twice the distance from the base to the pitch line of a normal gear of the same number of teeth. This cutter is related to the smallest of the three of the "abnormal gears" illustrated by you in your issue of December 9, 1897. The involute of this cutter is generated on the same base line as the cutter of Fig. 1, but being smaller in diameter and having the same depth of tooth, the addendum is reduced and the dedendum is increased. In Fig. 1 *a*, *b*, *c* show the relative fillets of the three cutters. The dotted line *d* and the full line *e*, Fig. 2, indicate the relative sizes of the second and third cutters.

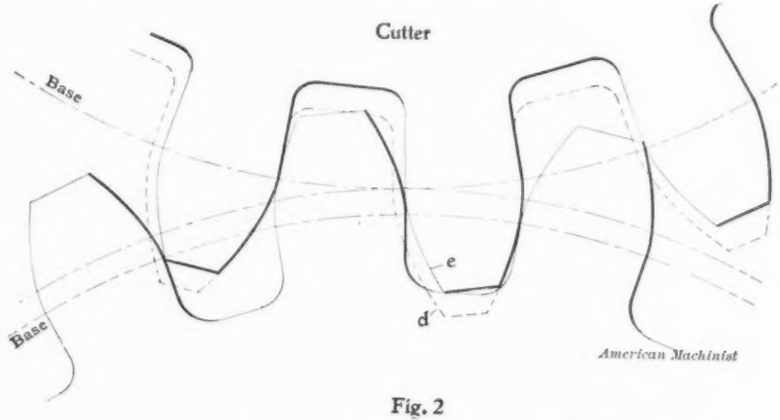


Fig. 2

CUTTER OF REDUCED DIAMETER BUT WITH NORMAL BASE LINE.

Perhaps the best answer to the "Second Error" is to say that we plane gears that do not show a tool mark, which would not be possible if the cutter did much gouging of stock. Of course the point of the tool removes the bulk of the stock, but this is to our advantage, as

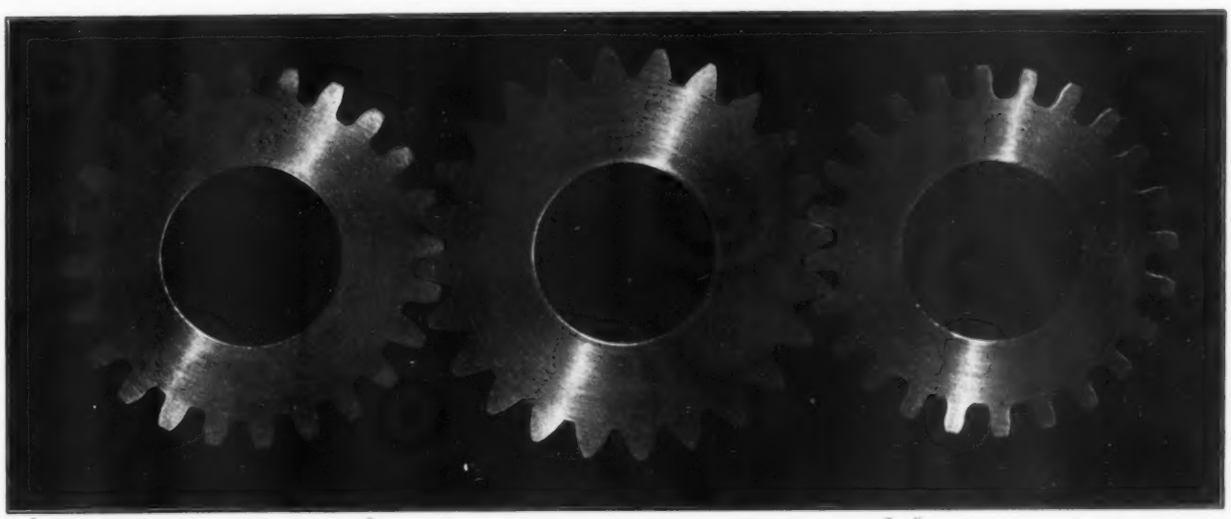
it relieves the part of the cutter that does the finishing of that much wear. This cutter cannot be run on the point of a toothpick, but must be controlled by a slide with generous bearing surfaces.

In view of the foregoing we therefore feel that the Goddess of Truth roosts on our ridge pole while we make the statement that our cutter produces a complete interchangeable set of gears.

There is one more feature of this system that we would have supposed that Mr. Grant would have criticised, and that is that theoretically we should use a cutter of twelve teeth to produce a rack that would mesh with a twelve toothed pinion without interference. We are sending with this a twelve toothed pinion, a segment of a 240 toothed gear, a rack, and a segment of a 136 toothed internal gear, all of which were cut with a twenty-four toothed cutter. We give this as evidence that we have other points up our sleeve, so to speak, that are not to be found in "Grant's Treatise on Gearing."

For fear that I have given the impression that I disagree with Mr. Grant in everything, I will add that I agree with him in saying that a machine embodying the Sang theory "is destined to be the chief means of cutting gear teeth in the near future." E. R. FELLOWS.

[It is proper for us to add that Mr. Fellows has given us entirely satisfactory evidence that his four gears, which we photographically reproduce below were cut by the same cutter. The teeth are, moreover, obviously in the condition in which the cutter left them.—ED.]



ABNORMAL GEARS.

Reprinted from our issue of December 9, '97.

INTERNAL GEAR, RACK, SPUR GEAR AND PINION FORMED BY ONE CUTTER.

▲ ▲ ▲

Countershafts and Loose Pulleys.

Editor American Machinist:

I wonder if anyone has ever suggested what is the most characteristic and unmistakable noise that belongs to the machine shop, and which is most apt to reveal the shop to the initiated passerby. I have an idea that it is the noise of the planer belt. The screech of the belt every time the motion reverses, and usually the difference of the screech at one end from that at the other, seems to speak a machine shop language which cannot be mistaken for anything else. I have been caught by it many times, and in the course of my wanderings by means of it I have often located a shop that gave no visible sign of its existence.

While the periodically recurring screech of the planer belt is probably the most characteristic constant noise of the shop, the most characteristic occasional noise, or, rather, two distinct noises of the shop—of some shops, let us say—are the squeak of the loose pulley when it wants oil and the rattle of the same loose pulley when it gets angry and asserts that it is not going to be neglected and imposed upon another minute. Loose pulleys frequently had to make emphatic remarks of this character in the olden time, and they still occasionally do so, but by no means as frequently as of old, and yet it is probable that on account of the incompletely solved loose pulley problem the countershaft remains one of the most unsatisfactory and troublesome things of the shop. It is somewhat surprising that amid the vast and rapid

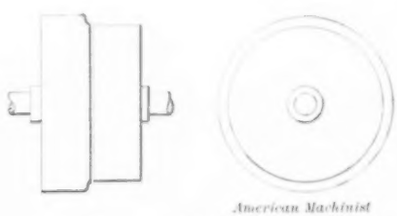


Fig. 1

FOR ACROBATIC BELTS.

changes in most of the appurtenances of the shop the countershafts have had so little improvement. I know that we have now a great many friction clutches on countershafts, but they only to some extent change the trouble without eliminating it, and indeed add some unwelcome complications. Our British cousins have not adopted to any appreciable extent, if at all, our friction clutch countershaft, and when they ask, as they are doing in some cases, what its advantages are, it is not easy to make much of a show in our answer.

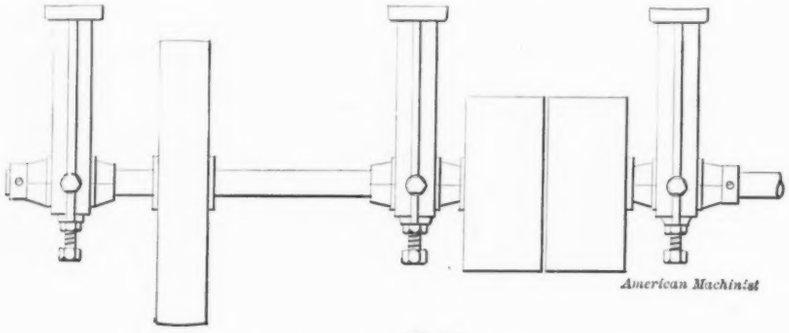


Fig. 2.

THE LOOSE PULLEY ON ANOTHER COUNTERSHAFT.

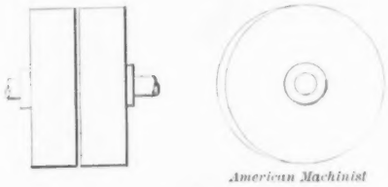


Fig. 3

OFFSET LOOSE PULLEY.

I suppose I ought to qualify my suggestion that the squeak and rattle of the loose pulleys are noises characteristic of the machine shop, because the wood-working shops have still more trouble with them than the iron workers. The wood workers have not to any great extent accepted the friction clutch pulley as a very satisfactory substitute for the loose pulley, and with good reason. The friction clutch pulley presents precisely the same problem of reliably lubricating a running pulley on a stationary shaft that the loose pulley does. With either style of pulley there is also the peculiarity that it never asserts itself while the machine to which it belongs is in use. When the entire machine is in need of lubrication the loose pulley of either type needs none, this condition having probably much to do with the fact of its neglect and the necessary assertion of its rights.

The makers of wood-working machinery seem to have given more attention to the loose pulley problem than the machine-tool makers have, or perhaps it is that they have sought amelioration in a different direction. To them we seem to be indebted for the brutal device of Fig. 1, where the loose pulley is of a considerably smaller diameter than the tight pulley, to make the belt slack when not driving. When the circular saw or other tool is to be started the belt must be made to jump up onto the larger pulley, one edge of the belt being demoralized by the shipper and the other edge by the act of climbing the steep edge of the pulley, and by the slip of starting the motion and getting up to speed with only the edge of the belt driving.

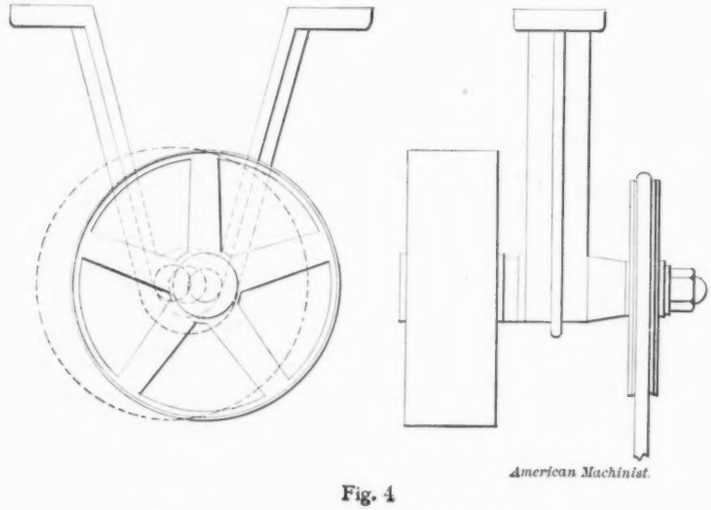


Fig. 4

ECCENTRIC CARRIER FOR LOOSE PULLEY.

The device shown in Fig. 2 first came to my attention, as used, in connection with wood-working machinery, and I have nothing to say against the arrangement, although there is some chance to kick on account of the expense of it. The difficulty of properly oiling the loose pulley is here gotten rid of by not having any. The pulley that takes the place of, and does the work of, the loose pulley is a tight pulley on the end of another countershaft placed in line with the actual countershaft which drives the machine. Instead of oiling the loose pulley the hanger boxes of the supplementary countershaft have to be oiled, but anybody knows enough to keep hanger boxes properly oiled in these days.

This arrangement does not provide for slacking the belt when not in use, and there is not so much need of it as with the loose pulley; but why should the two shafts be placed exactly in line? The idler pulley shaft might be placed a little nearer the line shaft, as in Fig. 3, thus slacking the belt when not in use, and also giving it a much easier climb than in Fig. 1 when starting up the machine.

This suggests another arrangement, Fig. 4, but here we have the loose pulley again; the belt, however, may be decidedly slackened when not in use. The driving pulley is on the end of the shaft, as in Fig. 2, and the loose pulley is on an eccentric stud running through a single solid hanger with a rope sheave for throwing the stud half way round from one position to the other. In one position the pulley will be in line with the pulley on the driving countershaft, and the belt may be easily shipped, and in the other position the belt is slackened when running idle. Oil holes may be provided in the eccentric stud for oiling the pulley at all times, and there should be stop pins for its two normal positions.

TECUMSEH SWIFT.

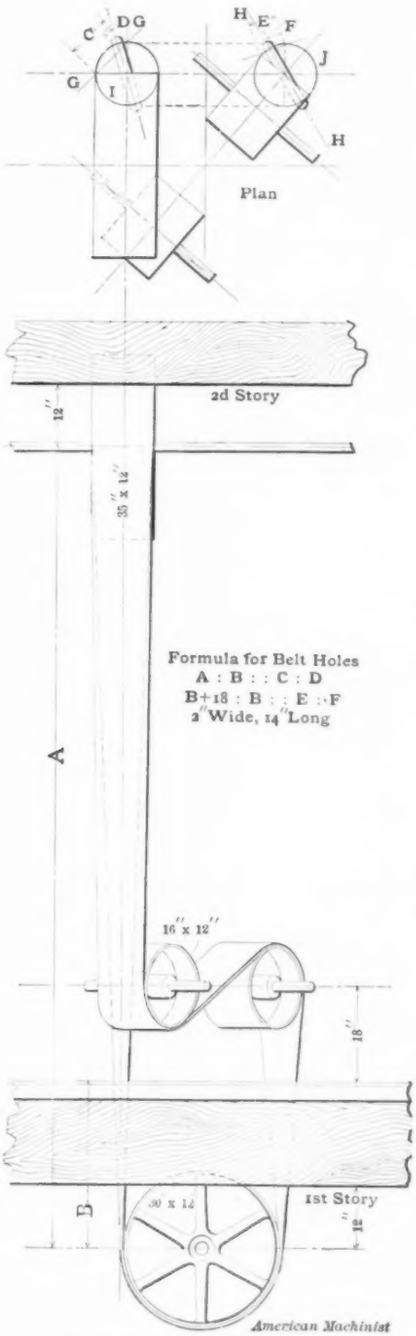
▲ ▲ ▲

Plotting Belt Holes in Floors and Partitions by Proportion.

Editor American Machinist:

If you will allow me I would like to say a few words about plotting belt holes, a rather peculiar subject, I will admit, but, strange to say, one that very few of our mechanics are thoroughly conversant with. That it is an important operation when installing a quarter-twist or angle-belt drive will hardly be questioned, yet few if any of our draftsmen ever think of showing the belt holes on a drawing, much less giving a formula by which the ordinary mechanic could lay them out on the floor. Of late I have been giving the matter some little attention and have arrived at the conclusion that it is the prevailing opinion, at least among the younger mechanics, that in order to

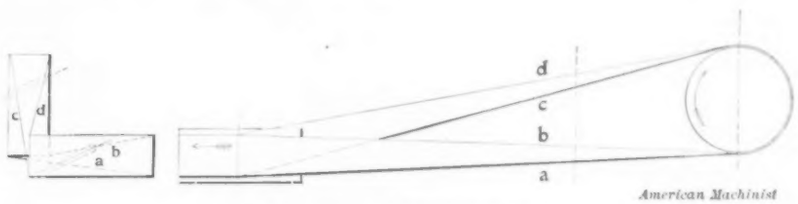
plot belt holes correctly it is necessary to lay out a plan and elevation of the building, so that they may be projected. If this were true, of course it would lie entirely with the draftsman, but my experience has taught me that the most satisfactory method of procedure is to plot them by proportion, which will



LAYING OUT BELT HOLES.

relieve the draftsman of all responsibility if he simply states the terms of the proportion on his drawing.

The sketch shows a four-pulley drive which I recently put in, consisting of one 30x12-inch pulley on main shaft, first story; one 35x12-inch pulley on main line, second story, and two 16x12-inch idlers supported by floor stands 18 inches high to center. Dimensions *A*, *B*, *C*, *D*, *E* and *F* I have purposely omitted, but the terms of the proportions are given. This saves time for the draftsman, gives the installing mechanic a pointer, and places the blame for mistakes, if any, where it rightfully belongs. Those familiar with erecting belt drives know that it is quite necessary to lay out a plan of the pulleys on the floor, with centers of shafts, etc., before the real work is begun, therefore dimensions *C* and *F* can be easily obtained by measuring from corner to corner without any extra work. After the shafts are in position dimensions *A* and *B* can be obtained, giving us three terms of the proportion to find the fourth.



LAYING OUT BELT HOLES.

For example:

Let $A = 12' 8''$, $B = 2' 8''$ and $C = 8\frac{1}{2}''$;

then $\dfrac{2' 8'' \times 8\frac{1}{2}''}{12' 8''} = D$, or 1.8" nearly.

Again let $B + 18'' = 4' 2''$, $B = 2' 8''$ and $E = 5''$; then $\dfrac{2' 8'' \times 5''}{4' 2''} = F$ or 3.2".

Having thus found the value of *D* and *F*, draw lines *G* and *H*, and with a radius of 6 inches (half the width of the belt) strike circles *I* and *J*, where lines *G* and *H* cross circles *I* and *J*, strike circles with 1 inch radius for end of belt holes; this makes them 2 inches wide when finished, which I think is about right for belts over 10 inches wide.

M. H. AVERY.

Woonsocket, R. I.

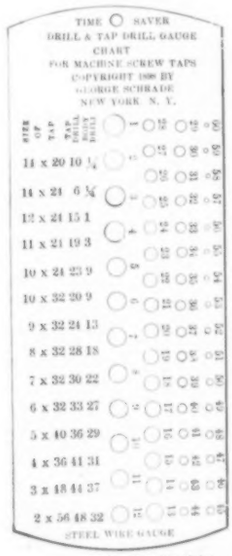
[The sketch of our correspondent shows a very good arrangement of pulleys when it is necessary to use a quarter-turn belt. The idlers prevent the stretching of one edge of the belt more than the other, enable it to bear perfectly on each pulley for the whole arc of contact, to lead straight both on and off each pulley, and to keep in place no matter in which direction the shafts may turn. The mode of locating the belt holes also seems to be all that could be desired. It probably would have been well, however, to have shown how to locate the holes for quarter-turn belts when no idlers are used, this being still the practice with too many misguided mechanics, and we add Fig. 2 to suggest the method. In this case the pulleys can, of course, turn only in the direction indicated by the arrows. If turned the other way the belt quickly runs off. The floor line is here above the lower shaft, one-third of the vertical distance between the shafts. Drawing *a*, *b*, *c*, *d* for the edges of the belts, and on the plan taking one-third of the length, gives points which locate the longitudinal direction of the holes, and they are then drawn with the ends equidistant from the center line and as long as may be required. With these unsatisfactory belts the holes never come just right, as laid out, as the belt bags out more or less from one side of the pulley and edgewise, also it slides more or less on the leaving side.—ED.]

▲ ▲ ▲

An Improved Drill Gage.

Most of our readers will probably agree with us that the inventor of the gage shown herewith has rendered a service to the craft by simplifying one of those little problems which, though classed among the less important ones, yet in the aggregate consume a great deal of time.

The device is a combination of a drill gage with a table of sizes for tap and body drills. With this gage in hand, drills that are right for tap and clearance are indicated and may be readily selected by the gage itself in case their sizes are not


TIME SAVER
DRILL & TAP DRILL GAUGE
CHART
FOR MACHINE SCREW TAPS
COPYRIGHT 1898 BY
GEORGE SCHRADE
NEW YORK, N. Y.
SIZE OF TAP
TAP DRILL
BODY DRILL
14 x 20 10 ¼
14 x 24 6 ¼
12 x 24 15 1
11 x 24 19 3
10 x 24 23 9
10 x 32 20 9
9 x 32 24 13
8 x 32 28 18
7 x 32 30 22
6 x 32 33 27
5 x 40 36 29
4 x 36 41 31
3 x 48 44 37
2 x 56 48 32
STEEL WIRE GAUGE
American Machinist

otherwise indicated. The inventor is himself a manufacturer, and the sizes of tap drills given are not intended to give a full thread, but to give a sized hole that can be readily tapped. The cut is half the size of the gage, which is made by George Schrade, 1337 Webster avenue, New York.

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An Analogy Between Tire Widths and Machine Design.

The action of the Governor of New Jersey in vetoing a wide tire bill brings to mind the fact that machinists ought to be intelligent and effective advocates of laws requiring wide tires on road vehicles. If a machinist should build a machine with its bearings proportioned absolutely without regard to the powers of resistance of the metals composing them, if as soon as the machine were started up it immediately began to rapidly destroy some of the important elements of which it was composed, so that frequent and continuous renewal of them would be necessary, and if the machinist should, upon having his attention called to this, insist that his proportions were all right and that they could not be changed, and that the fault was entirely with the metal makers for not supplying harder metal, we would say that machinist was crazy. Yet that is just precisely what wagon makers are continually doing. A wagon is a machine for the transportation of goods from one place to another. A road is a necessary adjunct to this machine, and common sense would seem to dictate that the wagon and the road should be so adapted to each other as that neither will immediately destroy the other. Yet anyone who observes wagons and roads at all knows that the pressure per unit of area between the ordinary tires of a wagon and the surface of the road on which it runs is far beyond the resistance of any practicable road making material, especially when roads are wet, as they must often be. It is a common experience to see a two-wheeled cart or a wagon with narrow tires follow a steam road roller and cut deeply into the surface left by the roller, illustrating what is in fact true—*i. e.*, that no steam road roller ever gives nearly so great a pressure per unit of area as is imposed by narrow tired and heavily loaded vehicles.

By requiring wagon owners to use tires wide enough to limit the pressure per unit of area between tires and road surface to an amount which ordinary road making materials can resist, wagons will pack, harden and improve roads instead of destroying them, and by making the forward axle shorter than the rear one by an amount equal to twice the width of the tires the surface rolled will be again doubled. Good wagon roads are as important, perhaps, as good railroads, if not, in fact, more so, and when the public has constructed them individuals should not be allowed to destroy them, especially when it is a demonstrable fact that there is no need whatever for doing so. Tests have shown that the wide tires lessen draft as well as protect roads, and they should everywhere be required by law.

▲ ▲ ▲

Government Control of Railroads in Russia.

The leading editorial in the "Railroad Gazette" of June 24 we are compelled to regard as a monumental example of specious reasoning. It gives an account of the utterly demoralized condition in which certain Russian railroads were found to be in 1891 when the transportation of large amounts of grain were needed to relieve a famine then existing in a certain portion of the empire, and concludes as follows:

"And yet there is no other country where the Government control of railroads is so absolute as in Russia. We recommend this example of inefficiency in a great emergency for the careful study and prayerful meditation of railroad commissioners and socialistic senators. An ounce of actual human experience is worth a pound of 'thoughts.'"

Now the real fact is that the railroads in Russia are managed about as Russian railroads would naturally be expected to be managed, whether under government control or not. We might easily cite our contemporary to private manufacturing establishments in Russia that are no better managed than are Russian railways. Because these establishments are not so well managed as our Springfield Armory, Watervliet Arsenal or Washington Gun Shop, will the "Railroad Gazette" argue from this that private ownership of workshops is bad? Yet here is "actual human experience" pointing in exactly the reverse direction to that indicated by our contemporary, and the argument is precisely as good one way as another and good for nothing either way. The very best equipped and managed establishments in St. Petersburg are government establishments, not private ones.

The official who reported the very bad condition of these Russian roads was Colonel von Wendrick, who was appointed by the Czar to take charge of them, and actually did so, presumably managing them much better than they had previously been managed; yet during his management the roads were probably more rigidly under government control than ever before.

A competent and trained observer writing upon Russia recently says, in effect, that Russia was a riddle to him until he ceased to consider it as European and classed it as Asiatic. He could then grasp the meaning of what he saw and heard. Yet we are told that because government railroads in such a country are not well managed, judged by our standards or by those of England, therefore and consequently government control of railroads is bad!

It is not our business to argue for or against government control of railroads. We confess we do not know whether government or private control of them here in this country would be best. There is much to be said on both sides, but what is said should be of such a character as will appeal to thinking people who are not in the habit of jumping to the conclusion that because two phenomena exist at the same time therefore one is the cause of the other.

▲ ▲ ▲

Questions and Answers.

Name and address of writer must accompany every question. Questions must pertain to our specialties and be of general interest. We cannot undertake to answer questions by mail.

(69) "Spirals" asks: Why does dividing 2.157 by the diametral pitch give the depth of a gear tooth and where is this 2.157 derived from? Diametral pitch means number of teeth per inch of diameter and the actual pitch of a diametral pitch gear, that is, the distance from the center of one tooth to the center of the next on the pitch line, is therefore 3.1416 divided by the pitch, because the circumference of a pitch line is 3.1416 times the diameter of the pitch circle. Since the thickness of a gear tooth at the pitch line

is equal to the space and therefore equal to half the pitch, the thickness of a tooth of given pitch is found by dividing 1.57 by the pitch, because 1.57 is half of 3.1416 and the clearance at the bottom of the tooth is 1-10th of the thickness and is therefore obtained by dividing 157 by the pitch, .157 being 1-10th of 1.57. The working depth of a tooth is twice its diametral pitch and is obtained by dividing 2 by the pitch. Consequently when the whole depth is to be obtained, *i. e.*, the working depth plus the clearance, we add 2 and .157 and divide their sum by the pitch. Thus

$$\frac{2.157}{P} =$$

whole depth of tooth. Applying this to an 8 pitch gear we have

$$\frac{2.157}{8}$$

or $2.157 \div 8 = .2696$ inch for the total depth of tooth.

▲ ▲ ▲

Foreign News Notes.

From Sydney, N. S. W., comes the information that there is a ready sale for reapers and binders, and several American firms do a good business there, as also in mowers. Our trade in this direction might be materially increased if our terms were more favorable. The usual terms asked by our manufacturers are cash against bills of lading in American ports, and as this is a request made by no English house it is somewhat against us.

Great Britain's orders for armor, guns, shot, shell and other war material at present in the hands of Sheffield firms are reported to be at least twice as large as they were this time last year. The contracts for the arsenals in the matter of engineers' tools are also largely in excess of their usual proportions.

A comparison of the imports of Japan for the first two months of the present year with those of last year for the same period show an increase in pig iron from 6,952,389 to 11,016,889 catties; of bar and rod iron, from 10,837,927 to 26,271,465 catties; of plate, sheet, diagonal, corrugated and galvanized, from 8,383,111 to 10,895,778 catties; of wire and telegraph wire, from 1,010,956 to 2,450,154 catties. In rails there is an increase of 10,000,000 catties, while manufactured iron has tripled. A. F. T.

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Death of M. Schneider.

An important man in the engineering world was M. Henri Adolphe Schneider, the director of the engineering works at Creusot, France, who died recently, fifty-eight years old. The world-famed works are considerably over a hundred years old, and they were prosperous at the beginning of the century, but ran down after the extinction of Napoleon. The father of the deceased, M. Eugene Schneider, with his brother Adolphe, bought the works in 1833 and developed it into one of the finest establishments in the world. A description of these works has been running in "Engineering," London, for some time, the latest chapter published numbering XXI. The son was early associated in the management of the works, and upon the death of his father in 1875 he became sole director. Important advances were made in recent years, especially in the manufacture of armor plates, and in the employment of steel instead of iron for the purpose. The works now occupy 800 acres and 15,000 men are employed. M. Schneider took a personal interest in the welfare of the employés of the establishment and did much to improve their condition.

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Some time before there was any expectation of difficulty with Spain, Commodore Schley remarked to a company of gentlemen, whom he met in a club in New York, that if the time should come when we should have any difficulty with a foreign nation, involving naval operations, there would probably be some surprises in store in connection with the performances of our gunners. He stated that the practice of gunners in the United States Navy, firing at targets, etc., was, he believed, more thorough and better than in any other navy in existence, and that the records showed that the marksmanship of the gunners in the American Navy was superior to that of any other. This fact he believed would exert an important influence upon any naval battles in which our gunners might take part, and his prediction seems to be borne out by recent events.

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During a recent voyage from Gibraltar to England of H. M. S. Terrible, one of the latest additions to the British navy, it was intended that she should make the run under 15,000 horse-power and at a speed of 19.5 knots. After three hours' steaming at the above-mentioned rate, however, it was found necessary, owing to signs of weakness in the cylinders and excessive vibration, to slow down, and she steamed the remainder of the distance under 7,000 horse-power and at a speed of 15 knots. The Terrible is a cruiser of 14,200 tons displacement and is supposed to develop 25,000 horse-power and to steam 22 knots, and there are signs of considerable disturbance of mind over the fact that in this voyage she was unable to maintain nearly her rated speed. One of the difficulties is said to be from the fact that owing to some peculiarity of construction the cylinders are unable to expand symmetrically and do not therefore retain their form at high temperatures.

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In an item regarding what are supposed to be the largest machines ever constructed for any purpose the pumping engines to be built by Lane & Bodley for the Cincinnati water works, we inadvertently omitted to state what is perhaps the most impressive fact regarding them—*i. e.*, that they will stand just 100 feet high from foundation plate to top of cylinders.

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Personal.

Our occasional contributor Joseph A. Rothwell has been placed in charge of all tools at the Pioneer Iron Works, William street, Brooklyn, N. Y.

Gilbert Bloss, Worcester, Mass.; John V. Miller, Orange, N. J., and Frederick J. Simmons, Portsmouth, Va., have been appointed assistant engineers, United States Navy.

Passed Assistant Engineers C. E. Rommel, H. G. Leopold, R. B. Higgins, W. P. Winchell, J. C. Leonard, F. H. Conant, E. T. Heiss and W. H. Chambers, United States Navy, have been raised to the relative rank of lieutenant.

Our contributor, Henry Hess, sailed for Germany last Saturday, where he will be for some months engaged on work in connection with the new Deutsche Niles Wergzeug-Maschinen-Fabrik, at Berlin Mr. Gordon's departure was delayed until the above-mentioned date also.

Th. H. M. De Grijs, of the firm of P. C. Muller & Co., Amsterdam, Holland, who has been here for some months looking about among our machine tool establishments, sailed for home on the 18th inst., and will prepare for an increased trade in American machine tools in Holland.

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Machinery Wanted by the Navy.

The Navy Department will shortly install a quantity of machinery in the navy yard at Mare Island, Cal., and for that purpose is inviting sealed proposals until July 13 for furnishing one combined punching and shearing machine; one motor-driven plate bending machine for ships' masts; one medium, multiple, belt-driven punching machine; two radial, jib, countersink drilling machines. An addition to the electric plant is also to be installed, and the following equipment is called for: One 100 K. W. dynamo and four 30 horse-power stationary dynamos, one 15 horse-power stationary motor, one switchboard and a quantity of cable wire.

Intending bidders desiring specifications and blank forms of proposals for the above can obtain the same upon application to the Paymaster General of the Navy, Washington, D. C., or to the commandant of the navy yard, or to the navy pay office at San Francisco, Cal.

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Obituary.

George Focht, head of the George Focht Iron Works Company, of Hoboken, N. J., died on June 19, seventy-five years old. Mr. Focht was born in

Eisenach, Germany, in 1823, and came to this country in 1849. While living in Reading, Pa., he invented the Focht self-dumping coal tub, from which he realized a fortune. He established the Focht Iron Works some years later.

Edward Marsland, a man of wide engineering experience, died in Ossining, N. Y., June 25, sixty-nine years old. His death was the result of a bullet wound self-inflicted three weeks before. Mr. Marsland was for many years connected with Howe, the sewing machine man, was at one time superintendent at the Roach shipyards at Philadelphia and was on the original Monitor on her first trip from New York to Norfolk.

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Commercial Review.

NEW YORK, Saturday Evening, June 25, 1898

DYNAMOS AND MOTORS.

The dull months of the year in the electrical machinery market are July and August. June should not be considered as such, although instances of waning trade are not apt to be absent. This year, however, June has shown a marked slackening of activity. There is a considerable amount of work, but of a trivial character. Small motors for a variety of purposes are in fair demand, but large contracts are few. Perhaps no class of work is more markedly held in abeyance than long distance power transmission schemes. A representative of one company tells us that his concern has on hand some fifty enterprises for the electrical transmission of power fifteen miles or over that have been hung up waiting for the dawn of a brighter day.

The demoralization of the prices of dynamos and motors and the narrow margins of profit received by manufacturers are bewailed in as loud a voice as ever. Yet some resistance is being offered to the unprofitable figures, for we are advised that the Fort Wayne Electric Corporation has instructed its agents to advance prices considerably.

The export field of the past month has been characterized by a good trade with Mexico experienced by one of the largest companies, and by miscellaneous sales of minor machinery to England, reported by certain other concerns. Some of the latter machinery was intended for printing press driving. In view of the fact that England was last year taken by storm by American manufacturers of electrical railway material it is affirmed that English builders are now quickening their energies to recover their territory from American occupation.

Advices from Buenos Ayres are to the effect that a concession for another electrical tramway in that city has been granted.

It is stated that the Westinghouse Electric & Manufacturing Company will shortly ship a complete electrical equipment for the underground and surface street railways of Paris.

A considerable quantity of electrical machinery is in requisition for Copenhagen. Three electric lighting engines have been sold by a company locally represented, for shipment to Kobe, Japan.

Some United States Government trade still hangs on to the electrical market. The big Brooklyn Navy Yard contract, for which bids will be opened on the 28th of this month, includes specifications for a 100 kilowatt generator and eleven motors. Among the more recent works of the War Department is the introduction of electric ammunition lifts in various coast fortifications. The C & C Electric Company has taken orders for a dozen 5 and 7½ horse-power dust proof motors to go with such lifts, manufactured by the New Jersey Foundry & Machine Company. Four have already been completed for Great Gull Island, N. Y., and those not yet finished are destined for Pensacola, Fla., and elsewhere. For Great Gull Island, also, the Bullock Electric Manufacturing Company has lately sold a lighting generator.

One of the many modern applications of electrical motors may be seen from the fact that the Hall Signal Company is now having 100 motors of one-sixth horsepower size built by the Crocker-Wheeler Electric Company for use upon its apparatus.

The General Electric Company is meeting with much success in selling an alternating current inclosed arc lamp which it introduced less than six months ago. The sales have already reached 8,000.

The Walker Company, Cleveland, is reported never to have been busier on large contracts than now. The order for the 4,000 horse-power direct current generator for the Boston Elevated Railroad Company goes in part to explain this fact. It is stated that the Walker Company has an important contract for power work now pending and likely to be announced in a few days.

A recent order for lighting apparatus is for an arc and incandescent plant to be installed in Coxsackie, N. Y. The Hyer-Sheehan Electric Motor Company, the contractors, have ordered Fort Wayne material.

For the electric light plant in the new court house in Baltimore, Md., bids were wanted by July 1.

MISCELLANEOUS.

A British diplomatic and consular report from Japan comments upon the rapid growth of Japanese trade with

Continued on page 35.

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Business Specials.

Gear wheels, gear cutting Grant; see page 16.

Forming Lathes. Mer. Mach. Tool Co., Meriden, Conn.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N. Y.

Cutters, reamers and small tools, regular and special; vertical millers, cutter and surface grinders, shears and punches. R. M. Clough, Tolland, Conn.

Wants.

Situations and Help Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. The cash and copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Situations Wanted.

Mech. draftsman. G. W., care of A. Haas, 108 Av. A., N. Y.

Wanted—By a mechanical engineer, practical machinist, expert draftsman and designer position as superintendent or foreman. Box 118, AM. MACHINIST.

Young man, 32, eleven years' experience, all round machinist and draftsman, wants position as foreman, asst. supt. or designer. Address Box 117, AM. MACH.

First-class machinist, with four years' experience, desires position in Boston, in store or shop where machine tools are sold or made. Address Box 114, AMERICAN MACHINIST.

Wanted—Position as superintendent by thoroughly competent man (38); up to date in manufacture of machinists' tools; very best references; would not object to go abroad. Box 108, AMERICAN MACHINIST.

Wanted—A position as gen. sup't or manager; extensive practical exp. in metal working industries, including electrical apparatus, engines, power transmitting and mining mach., etc. Address Box 107, AM. MACH.

Help Wanted.

Agents in every shop to sell my line of tools; very liberal induc'm'nts. Address E. G. Smith, Columbia, Pa.

Wanted—Superintendent for machine shop, making presses, dies, etc., for sheet Metals; good and steady pos. with reliable firm. Address Box 116, AM. MACH.

Wanted—In small shop in New England a young man as draftsman and machinist; must have two or three years' experience in drafting room corps. Box 121, AMERICAN MACHINIST.

Wanted—Salesmen who call on manufacturers to sell two patented popular vises in connection with other lines they handle; liberal commission to right parties. Address P. O. Box 2347, New York City.

Mechanical draftsman to assist in designing automatic machinery and to make construction drawings; state experience and wages expected. John Adt & Son, F. B. Shuster, proprietor, New Haven, Conn.

Wanted—One or two good lathe hands and one good boiler maker for general job machine shop in Western Pennsylvania. In applying give age, experience and habits, and address Box 119, AMERICAN MACHINIST.

Wanted—Mechanical engineer of large experience, competent to take charge of drafting department in an establishment building Corliss engines and employing several hundred men. References and record of services required. Address Box 102, AMERICAN MACHINIST.

Wanted—Salesman to reside in Germany and travel for American machine tool manufacturer; must have necessary American sales' experience; a German technical school graduate preferred. Reply, stating fully experience, age and salary expected, Kilo, AM. MACH.

Miscellaneous Wants.

Advertisements will be inserted under this head at 30 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Best Calipers, Levels, etc. E. G. Smith, Columbia, Pa.

Book, Dies & Die Making. $1. J. L. Lucas, Prov., R. I.

The Dutton Wet Twist Drill-Grinder is sold by the Garvin Machine Co., New York City.

Best and cheapest Bolt Header, made by Baush & Harris Machine Tool Co., Springfield, Mass.

Light and fine mach'y to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

For Sale—Second-hand drill presses, engine lathes and planers. Detz, Schumacher & Boye, Cincinnati, O.

For Sale.—One Merriman bolt cutter, 3-8 in. to 1 1-2 in.; one 1-2 in. to 2 in.—new. The Melrose Foundry Co., New Haven, Conn.

Wanted—One 8 or 10 foot boring mill, with two heads; must be in good condition and cheap for cash. F. C. Austin Mfg. Co., Harvey, Ill. (Chicago suburb.)

A company employing 120 hands on small mechanical goods desires more favorable location, vicinity of Chicago preferred. Address Box 103, AM. MACHINIST.

Wanted—An active or silent partner, with $5,000, in a contracting and engineering office; if active should prefer one familiar with drafting and supervising. Box 115, AMERICAN MACHINIST.

Wanted—To lease or operate a machine shop and foundry or boiler shop by young man, experienced in management of such a business and a practical shop man. Box 120, AMERICAN MACHINIST.

Wanted—Manufacturer to buy or build on royalty best gas and gasoline eng. yet pat'd; perfectly balanced and entirely valveless; equally suited large and small powers, specially dynamos. Box 111, AM. MACHINIST.

Institutions retiring from business having machine tools, brass or wood working machinery, will find it to their interest to correspond with us. We purchase complete plants or handle them on com. C. C. Wormer Mach Co., 55-59 Woodbridge st., W., Detroit, Mich.

A firm of engineers and tool merchants in England, doing a large business in American machine tools, is desirous of opening up communications with tool manufacturers in America, and will be pleased to receive their catalogues. Address Tool Co., care of the Cassier Magazine Co., 3 West 29th St., New York.

RUSSIA.

WOSSIDLO & CO.,

MERCHANTS AND ENGINEERS,
ST. PETERSBURG and... MOSCOW.

Represented in all important towns of Russia.

Contractors to the Imperial Russian Navy, Artillery, Railroad and Mining Department, Etc.

Are open to enter into correspondence with first-class American firms with a view to representing them in Russia, and request price lists of machinery and of all recent technical inventions.

The CROSS OIL FILTER

actually reduces oil bills 50% or more. Sent on approval. Capacities 3 to 120 gals. per day. Used in 18 countries. Testimonials from the leading firms in every field of industry.

THE BURT MFG. CO.
AKRON, OHIO, U. S. A.

Business Established 8 Years.

Largest Manufacturers of Oil Filters in the World.

S. WIENER,

Zwolle, Holland,

Invites correspondence with first-class manufacturers of

American Machinery AND TOOLS.

REFERENCES ON APPLICATION.

KEUFFEL & ESSER CO.
NEW YORK.
127 FULTON STREET.
Branches 111 Madison St., Chicago.
708 Locust St., St. Louis.
Drawing Materials and Surveying Instruments.

We make and carry the most complete and best assorted stock in America. Our goods are recognized as the standard of quality. They all bear our trade mark and are warranted by us. Our prices are reasonable. Our lavishly illustrated catalogue minutely and correctly describes our goods. It contains much valuable information and is sent gratis on application.

Milling Machines.

KEMPSMITH ... Machine Tool Co.,

MILWAUKEE, WIS., U. S. A.

DON'T be afraid to buy a Milling Machine because it is made out West. The know-how was acquired in the East and then taken out West and applied, with the additions made possible by the bracing Western climate.

We build ten sizes of Milling Machines, from 600 lbs. to 4,500 lbs. weight.

EUROPEAN AGENTS:

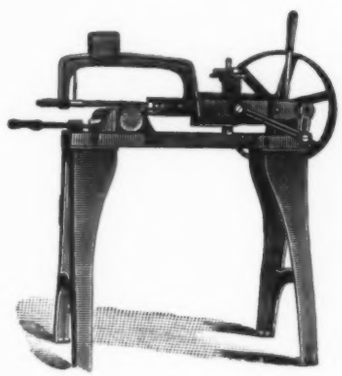
SELIG, SONNENTHAL & CO.,
85 Queen Victoria Street, London, Eng.
E. SONNENTHAL, JR.,
Neue Promenade 5, Berlin, Germany.

"The best is as good as any."

The New

Automatic and Gravity Feed

Q & C Shop Saw



Cuts { Tool Steel, Machinery Steel, Iron, Brass and All Other Metals.

Price—'Way Down.
Quality—'Way Up.

Shop Saws,

Portable Rail Saws,

Cold Power Saws,

For All Purposes.

Send for Catalogue.

Q & C Company,

Chicago. New York.

LONDON: Chas. Churchill & Co.
PARIS: Hounsfield & Fils.
BERLIN: Schuchardt & Schutte.
MADRID: J. G. Neville & Co.

Continued from page 34.

America, particularly in machinery and locomotives and railway material. It is said that the American locomotive builders have an advantage over the British in the quick deliveries which they can give. In one case the English makers required two years for the delivery of an order which the Baldwin Locomotive Works completed in eight or ten weeks, turning out the engines at the rate of two a day. In another case the English builders asked ten months for five locomotives at the rate of $12,000 gold each, delivered in Japan. The Americans offered to ship the same in fourteen weeks at $8,000 gold apiece. "The time allowed for execution of orders by the Japanese buyer is always short and the tendency is to make it shorter still."

The American Wheelock Engine Company, Worcester, Mass., sends us a list of some engines recently sold or installed by it. Among them the following are particularly worthy of note: Six 1,500 horse-power engines for the Chicago City Railway Company, with rope drives; one 600 horse-power single cylinder, condensing engine for the Worcester Wire Mill; one 1,000 horse-power for B. B. & R. Knight, Providence; one 550 horse-power single cylinder and one 550 horse-power cross compound, with rope drives complete, for Syracuse Construction Company; one 750 horse-power direct connected for New York Heat, Light & Power Company; three 350 horse-power direct connected for J. G. White & Co., New York; two 500 horse-power cross compounds, direct connected, for Potomac Electric Power Company, this being the second order from them; the previous one having been for two 750 horse-power direct connected engines.

GOVERNMENT CONTRACTS.

The Secretary of the Navy is now advertising for proposals for the construction of three new battleships. Forms may be had on and after July 25, and the bids will close September 1.

Bids are now being called for to furnish the Mare Island Navy Yard a 100 kilowatt dynamo, four 30 horse-power stationary dynamos, a combined punching and shearing machine, a motor-driven plate bending machine for ships' masts, a medium multiple belt-driven punching machine, two radial, jib, countersink drilling machines, etc. Bids close July 13.

CHICAGO MACHINERY MARKET.

Summer is to be tided over by the larger builders of machinery without the necessity of making any very heavy drafts upon their respective sales departments. The conditions are thus eminently satisfactory to both managers and salesmen. In the advent of the Saturday half holiday, and in a noticeable sedateness of manner throughout the week, the blandishments of outing times are being felt, even in

machinery circles. Trade, on the whole, is reasonably satisfactory. Perhaps with a majority of machinery sellers business would be described as quiet. It is the special activity of the manufacturers of the larger machinery that pulls up the average to a respectable altitude.

Orders are not confined to the largest class of machinery, however. The railroad shops take moderately sized tools, and they are now, as they have been for some time, very good buyers of shop equipment as well as of track equipment. Reasonable certainty exists of large crops to move this year, and the experiences of last winter, when upon many roads there were serious blockades and other causes for delays in the freight movement, are evidently not to be repeated, if greater precautionary measures will prevent them. The reported laying off of a large number of men in the Chicago & Alton shops at Bloomington last week is probably explainable by the almost total suspension of operations at the coal mines on that road south of Springfield, and the consequent cessation of an important traffic. It is the only coal territory where wage troubles now exist.

Among the shops that are running at full speed the alternative is now presented to prospective buyers to go elsewhere or to accept distant deliveries. Some foreign business has been placed by Western makers recently that is highly gratifying to the sellers. The inquirers were foreigners, and when they were discouraged by the manufacturers, because of previous engagements, the men who had crossed the ocean to buy would not be put off. They accepted whatever terms could be made and went away apparently happy.

Lines that are latterly related to the machinery tool trade are making good reports of themselves. Flour mill machinery in the West is active. The number of plants of this kind that are refitting is said to be quite large at this time. No diminution appears in the demand for mining machinery, and manufacturers do not gain on their orders.

Crude iron has clear sailing ahead for some two or three months at least, if all buyers were to disappear from view. This remark applies generally. By way of exception billets and rods are quiet, and mills may close down next month if consumers longer delay their purchases. Plate mills are crowded with orders, sheet mills are fairly provided for, bars have been sold in large quantities, and pig iron is not produced in sufficient tonnage by the more influential factors of this market to satisfy consumers.

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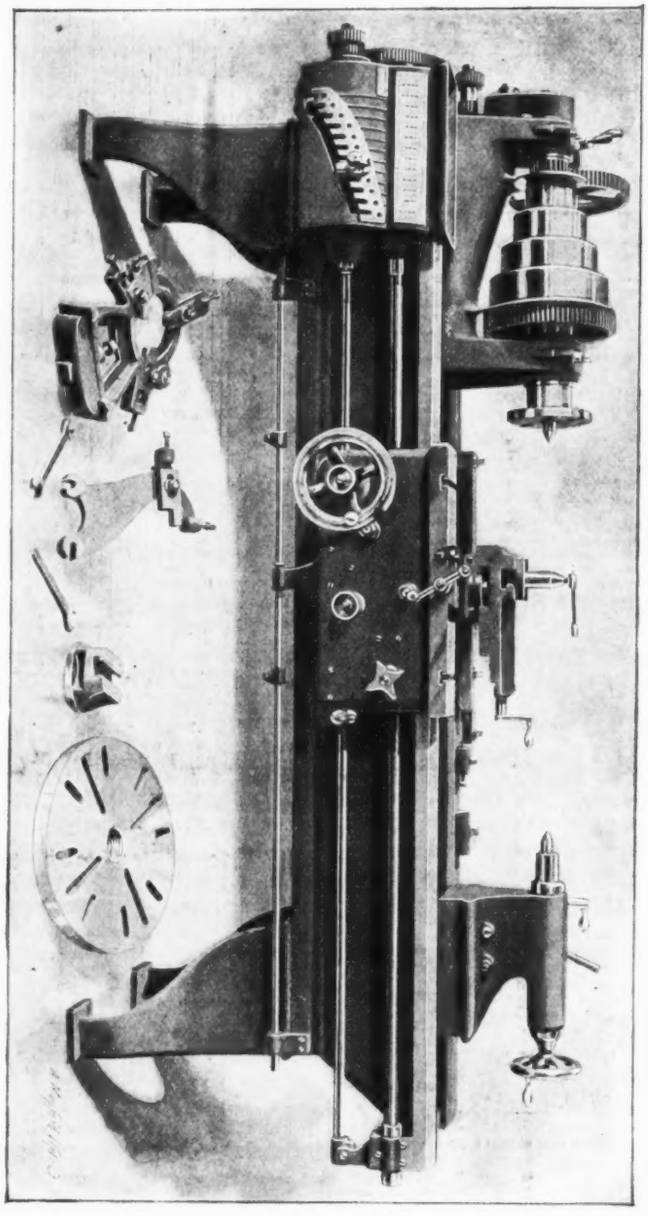
Quotations.

NEW YORK, Monday, June 27.

Iron—American pig, tidewater delivery:	
No. 1 foundry, Northern	$11 00 @ 11 50
No. 2 foundry, Northern	10 50 @ 11 00
No. 2 plain, Northern	10 00 @ 10 50
Gray forge, Northern	9 75 @ 10 00
No. 1 foundry, Southern	10 50 @ 10 75

20 in. x 8 ft. Hendey=Norton Lathe.



ALL these Lathes have the Norton Screw Cutting feature. All the different threads and feeds in daily use obtained by moving the handle in gear box from one notch to the other. All sizes but the 32 in. fitted with our Automatic Stop Rod for carriage. By its use you can cut threads to and from shoulders and always have the carriage stop in the same place. All lathes have the reverse motion in head, operated by lever at side of apron. By this you reverse the carriage only, which is all that is necessary in cutting threads.

These attachments mean a great saving of time and labor.

THE HENDEY MACHINE CO.,

Torrington, Conn.

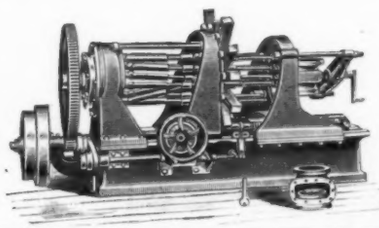
AGENTS FOR THE PACIFIC COAST:

PACIFIC TOOL AND SUPPLY CO., . San Francisco, Cal.
J. W. CREGAR, . . Philadelphia Bourse Exhibition.

EUROPEAN AGENTS:

SCHUCHARDT & SCHUTTE, Berlin, Vienna, Brussels, Stockholm.
CHAS. CHURCHILL & CO., Ltd., London and Birmingham, England.
ADOLPHE JANSSENS, ... Paris, France.

HORIZONTAL ADJUSTABLE 16-SPINDLE DRILLING MACHINE



For Drilling Holes 1⅜" diameter sixteen at a time in valve flanges, or a less number of larger or smaller diameter grouped in circles, squares and other forms.

Vertical machines of several sizes and styles of similar character, Gang Drills, etc.

Ask for the Machinist's Catalogue.

The Pratt & Whitney Company,
HARTFORD, CONN., U. S. A.

NEW YORK: 123 Liberty St. BOSTON: 144 Pearl St. CHICAGO: 42 South Clinton St. LONDON, ENGLAND: Buck & Hickman, 280 Whitechapel Rd. PARIS, FRANCE: Fenwick Freres & Co., 21 Rue Martel.

ENGINE and SPEED LATHES

IN VARIOUS LENGTHS—9 to 15 in. SWING.
Latest and Most Approved Designs. Workmanship, Material and Finish of the Highest Order.

SEBASTIAN LATHE COMPANY,
117 and 119 Culvert Street, CINCINNATI, OHIO, U. S. A.
Agents: SELIG, SONNENTHAL & CO., London, Eng.; JOHN TRAGARDH & CO., Göteborg, Sweden; E. SONNENTHAL, JR., Berlin, Germany; R. S. STOKVIS & ZONEN, Rotterdam, Holland.

FIRST EDITION. FIRST THOUSAND.

THE RESISTANCE AND PROPULSION OF SHIPS.

BY
WILLIAM F. DURAND,
Principal of the School of Marine Construction, Cornell University.

8vo. vii. + 461 pages, 116 figures. Cloth, $5.00. Order through your bookseller, or copies will be forwarded postpaid by the publishers on receipt of the retail price.

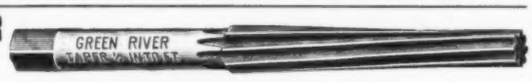
John Wiley & Sons, 53 E. 10th Street, New York City.

FINE SPIRAL FLUTED TAPER REAMERS.

Ground accurately to gauge.

Send for Catalogue

WILEY & RUSSELL MFG. CO.,
GREENFIELD, MASS., U.S.A.



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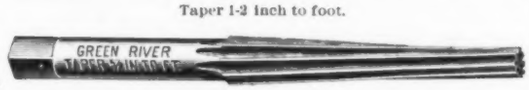


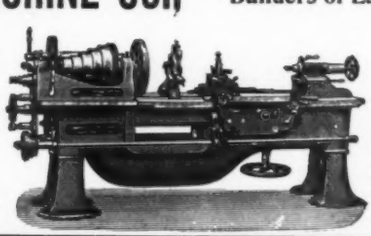
Taper 5-8 inch to foot.

Agents in London, SELIG, SONNENTHAL & CO., 85 Queen Victoria Street.

PUTNAM MACHINE CO.,

The Oldest and Most Extensive Builders of Lathes in America.

LATHES, PLANERS, DRILLING MACHINERY, MILLING MACHINES, SLOTTERS, SHAPERS, GAP ENGINE LATHES.



RAILROAD SHOP TOOLS, GAP PATTERN MAKERS' LATHES, &c.

Correspondence Solicited.

8 to 100 Putnam St.
Fitchburg, Mass., U. S. A.

Jenkins Standard '96 Packing

weighs 33-1/3 per cent. less, does not **Rot, Burn** or **Blow Out,** and will last longer than other joint packings; therefore the cheapest and best for all purposes.

Good buyers compare weights.
Genuine stamped like cut.

JENKINS BROS., New York, Boston, Philadelphia, Chicago.

The Walker Cutter and Reamer Grinder.

The illustration shows this grinder arranged for cutter and reamer grinding only, and is designed to fill the demand for a machine not so elaborate as a complete grinder, but so arranged that the different attachments which are interchangeable can be added when desired.

Norton Emery Wheel Co.,
Worcester, Mass.

No. 2 foundry, Southern..... 10 00 @ 10 25
No. 3 foundry, Southern..... 9 75 @ 10 00
No. 1 soft, Southern..... 10 50 @ 10 75
No. 2 soft, Southern..... 10 00 @ 10 25
Foundry Forge, Southern..... 9 50 @ 9 75

Bar Iron—Base—Mill price, in carloads, on dock: Common, 1.05 @ 1.10c.; refined, 1.10 @ 1.20c. Store prices: Common, 1.25 @ 1.35c.; refined, 1.30 @ 1.50c.

Tool Steel—Base Sizes—Standard quality, 6 @ 7c., with some grades perhaps a little less; extra grades, 11 @ 12c.; special grades, 16c. and upward.

Machinery Steel—Ordinary brands, from store, in small lots, 1.40 @ 1.45c.

Cold Rolled Steel Shafting—Base sizes, from store, 2.05 @ 2.10c., according to quantity.

Copper—Carload lots: Lake Superior ingot, 11¾c.; electrolytic, 11⅜ @ 11½c.; casting copper, 11¼ @ 11⅜c.

Pig Lead—Carload lots, 3.95 @ 3.97½c., f. o. b., New York.

Pig Tin—For 5 and 10 ton lots, 15.30 @ 15.35c., f. o. b.

Spelter—Carload lots, 5.10 @ 5.25c., New York delivery.

Antimony—In cask lots: Cookson's, 9½ @ 9⅝c.; Hallett's, United States and French E. B., 9c.; Japanese, nominally 9c., but little, if any, on the market.

Lard Oil—Prime city, wholesale—a leading brand of ice-pressed is reported barely steady at 52 @ 53c.; and some brands, present make, are quoted from 49c. up.

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Manufacturers.

The Conway (Ark.) Milling Company is erecting a flouring mill.

The Frith & Foster Company, of Philadelphia, is erecting a new factory.

J. W. Gray & Brother's paper mill at Chester, Pa., was recently destroyed by fire.

The Griffith Paper Company, of Niles, Mich., is about to erect a paper bag factory.

McDougall & Co., Galt, Ont., will add another story to their foundry building.

Janesville (Wis.) Barb Wire Works is to have a new factory added to the present plant.

The First New York Beet Sugar Company, of Rome, N. Y., has decided to expend $25,000 in making improvements to the factory.

The De Laney Forge & Iron Company, of Buffalo, N. Y., was recently incorporated by Jas. Howard, John Slate and W. A. Robbins.

At Iola, Kan., the spelter plant of Robert Lanyon's Sons was recently destroyed by fire. It is the intention to rebuild the plant immediately.

The Liberty Woolen Mills, at Bedford City, Va., are enlarging by the construction of an additional building. They will install new machinery.

The new two story frame factory, 125x64, for the Eureka Chemical Works, will be erected at Hancock and Fourteenth streets, Long Island City, L. I.

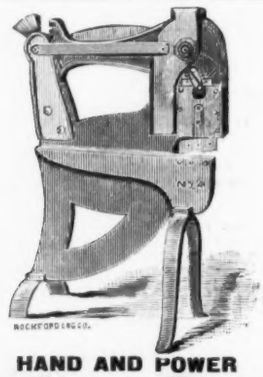
Morris & Tregloan Company, Sacramento, Cal., has been formed to manufacture and construct mining machinery. John B. Tregloan, Charles H. Lamberton, H. D. Morris and H. W. Morris are interested.

The Martin-Muir Company has been formed to do a general foundry and machine business. Principal place of business, Nevada City, Cal. Directors—William H. Martin, David D. Muir, Joseph G. O'Neill, all of Nevada City.

The Moore Manufacturing Company, Cleveland, Ohio, has been granted a building permit for the erection of a machine shop at the corner of Kirtland and Lake streets, that city. The estimated cost of the structure is $13,000.

The Builders' Iron Foundry, of Providence, R. I., has taken up the regular manufacture of the grinding and polishing wheel stand illustrated and described in our issue of November 11, 1897, in a letter written by Mr. C. H. Norton.

Springfield Machine Tool Company, Springfield, Ohio, have found their present accommodations inadequate, and are building a new foundry. The old foundry will be used as an erecting shop, thus giving more room in the machine shop.



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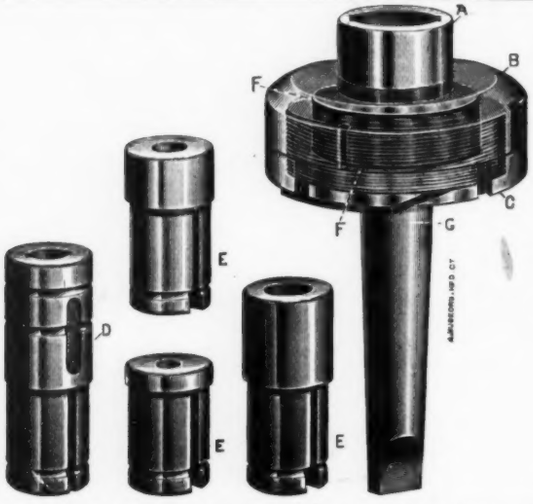

FOR years men have pulled and twisted to force a a tap into a hole and get it out again, and finally some genius thought he could do it by power. Tried. Did it, but broke taps. Then another, and then several other geniuses went at it. Finally one produced the **Safety Drill and Tap Holder** herewith shown. It worked beautifully. He got it patented and we make it. Hundreds are in use. It can be used in any spindle that turns around. You want it, for it saves time, money and labor.

Beaman & Smith,
Providence, R. I.

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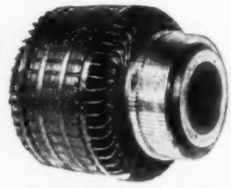
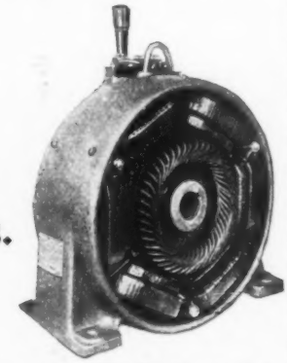

Armature for 5¼ K W "Engine Type" Generator.

Direct-Connected Generators.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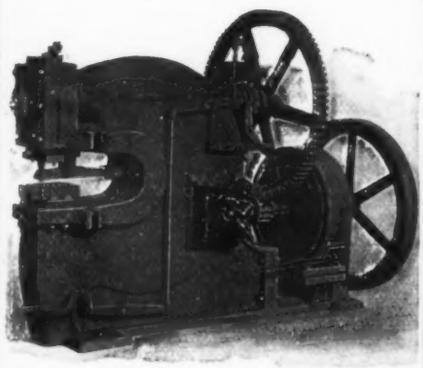

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FIXED CALIPER GAUGES.

Manufactured after the RICHARDS SYSTEM.

Our 1898 Tool Catalogue will tell you all about it.

THE JOHN M. ROGERS,

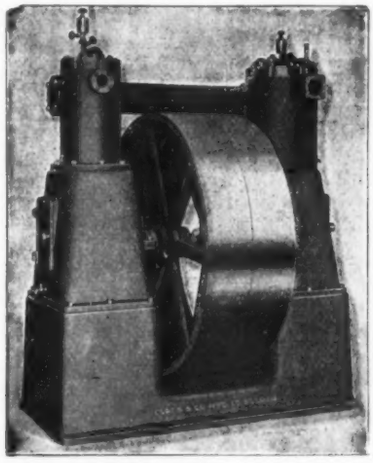
Boat, Gauge and Drills Works.

GLOUCESTER CITY, N. J., U. S. A.

This cut shows the

Curtis Compound Air Compressor.

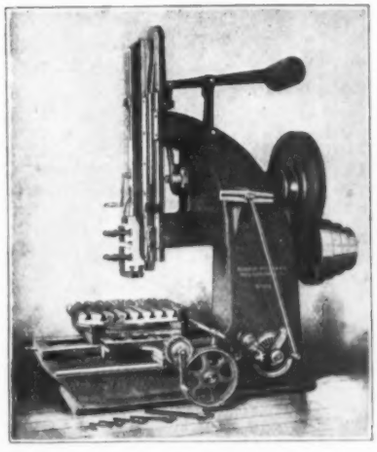
These compressors have been especially designed for use with Pneumatic Hammers, Drills, Hoists, Pumps, etc. The sp cial features of these machines are as follows: Simplicity, efficiency, durability, minimum attention required, cheapness and interchangeability of parts; economical governing; exclusion of dust from valves and cylinders, generous weight and dimensions of parts, small cost of installation; capacity from 25 to 100 c. f. A very full description of the economical attributes of this machine will be sent for the asking.



Curtis & Co. Manufacturing Co.

New York Office, 126 Liberty St.

Sixteen inch Slotting Machine.



Stroke, 16½ inches, with adjustment for any position and length of movement. Cutting bar has eight speeds, with counterbalance, quick return motion, and tool lifting apron. It is also provided with a reinforcing guide, vertically adjustable by screw to suit the work. Feeds positive and variable by cam, self-acting in all directions, operating at upper end of stroke, and so arranged that all can be controlled by the workman from one position. Distance from front of cutting bar to inside of frame, 34 inches, affording space for the keyseating of a 76 inch wheel. Compound tables have an adjustment of 41 inches longitudinally, by 32 inches transversely, and support a revolving rectangular table 36 inches in diameter, or 43 inches across the corners, which may be fixed in position by corner clamps when circular feeds are not in use. When so ordered, the tool lifter may be made to work automatically for any stroke or position of cutting bar. Countershaft, wrenches, etc., included.

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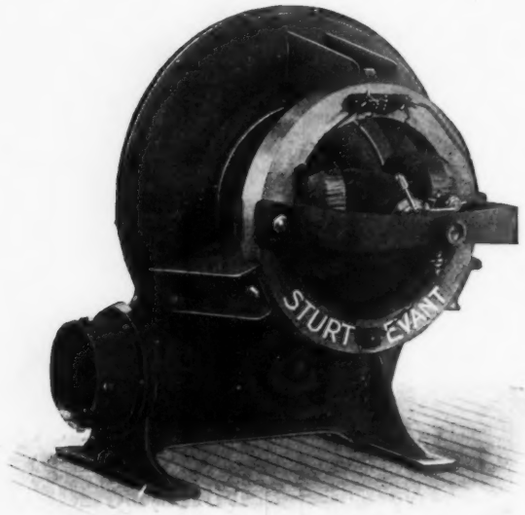
Sturtevant Electric Fans.



These engravings of recent designs indicate possible special arrangements. The fans shown above are of the Pressure Blower pattern. The tightly fitting cases for the motors are of great service in a dusty atmosphere.

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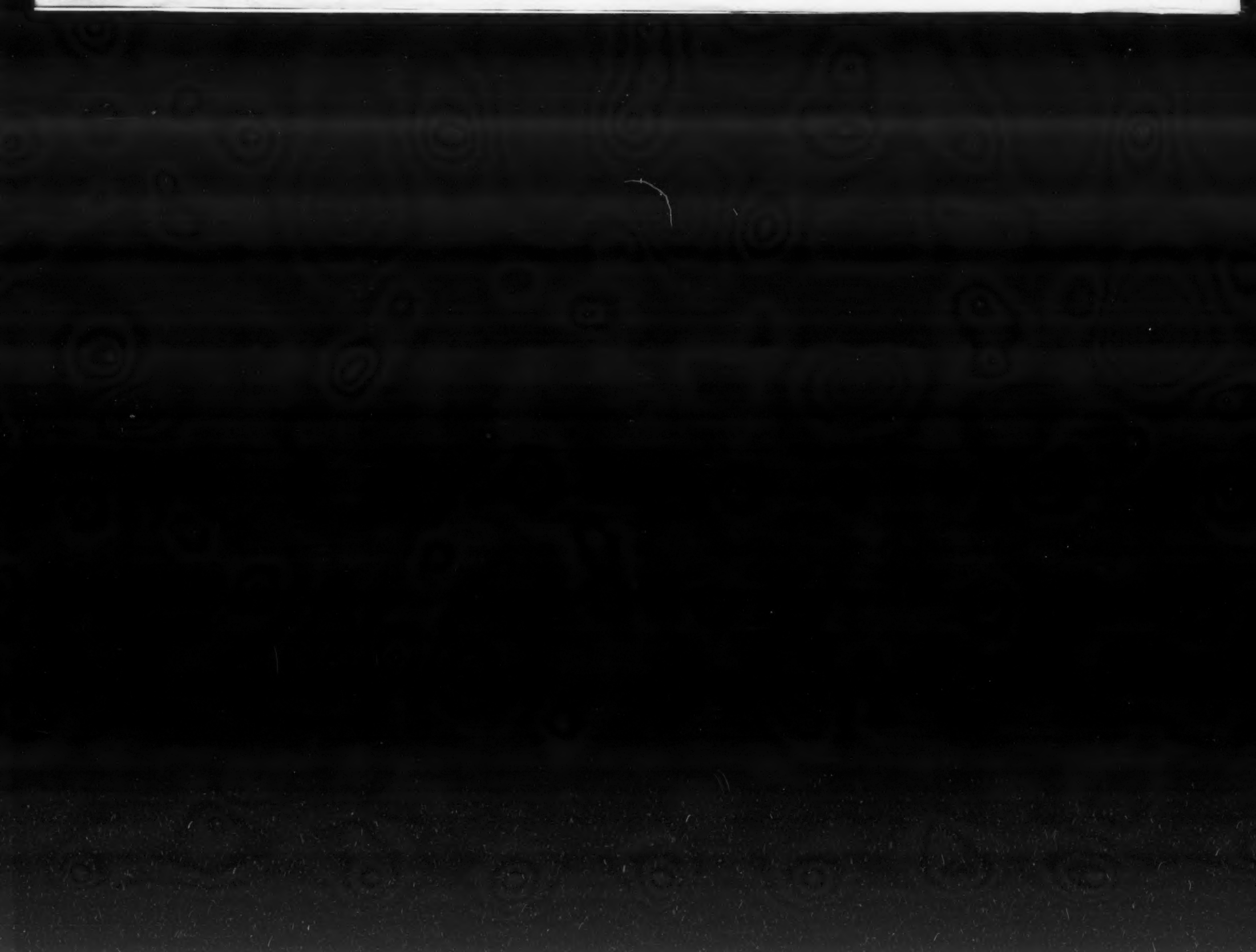

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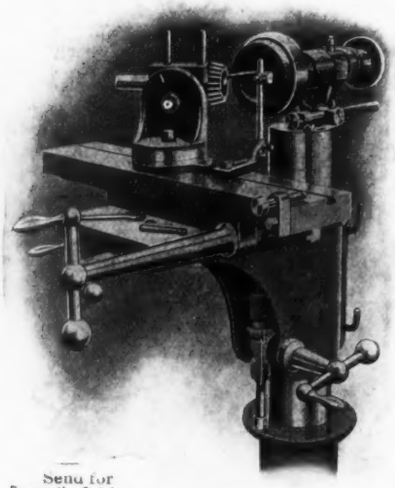
Wheel runs TOWARD THE CUTTING EDGE of Cutter.



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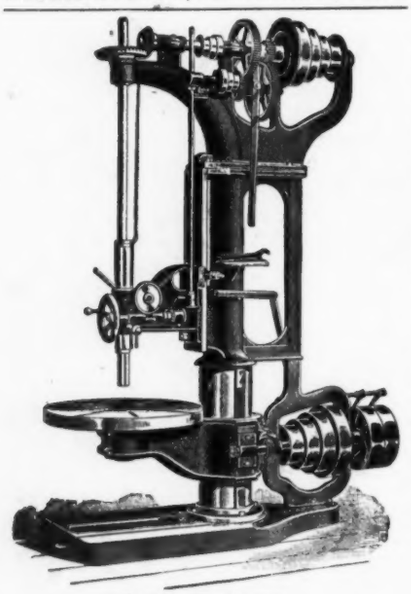

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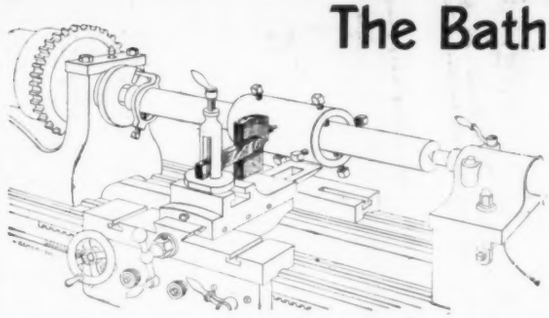

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40 inch Swing.

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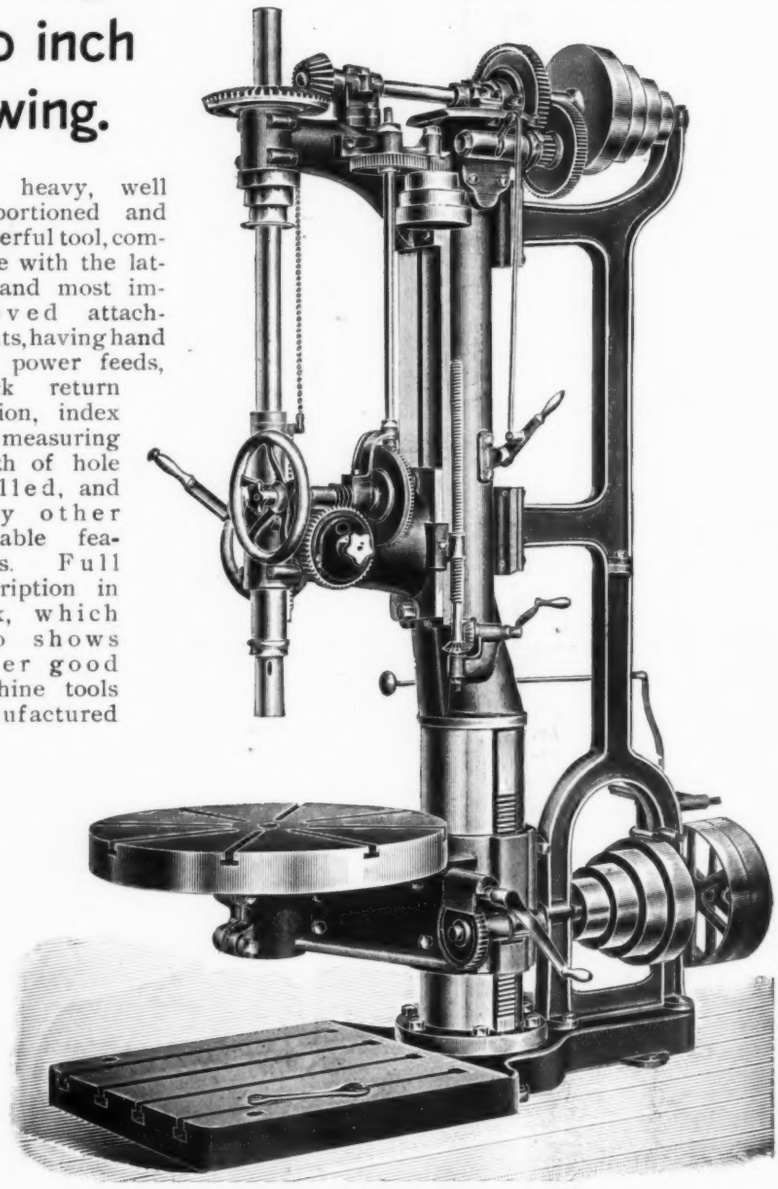

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Cleveland Automatic Screw Machines.
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Full particulars and prices on application.
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THE MOORE CYCLE FITTINGS CO.,
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Lathes, from 12" to 48"; Planers, from 20" up to 60. 48", 54" and 60" Radial Drills; No. 2 Newton Milling Machine; No. 2 Screw Machine; Shapers, from 6" to 30", Boilermakers' Punches, Shears, Edge Planers, Rolls, Drills, Engines, Boilers, Pumps, and Dynamos.
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1 11 in. x 4 ft. Lux.
1 14 in. x 3 ft. 6 in. Putnam.
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1 32 in. x 13 ft. Bement.
1 48 in. x 18 ft. G. & S.
1 48 in. x 16 ft. Fifield.

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2 16 in. x 16 in. x 4 ft. Hendey.
1 24 in. x 24 in. x 6 ft. Powell.
1 28 in. x 28 in. x 8 ft. G. & S.
1 30 in. x 30 in. x 8 ft. S. & S.
1 30 in. x 30 in. x 10 ft. Niles.
1 32 in. x 26 in. x 12 ft. Gray.
1 36 in. x 36 in. x 12 ft. Powell.
1 36 in. x 36 in. x 18 ft. Sellers.
1 54 in. x 54 in. x 20 ft. Niles.

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1 9 in. traveling head, Wm. Sellers.
1 13 in. Traveling Head, Bement.
1 16 in. G. & E., triple G.
1 16 in. G. & E., single G.

DRILLS.
1 34 in. Harris, Bk. G.
1 32 in. L. & D.
1 3-spindle Hendey.
1 No. 3 4-spindle Garvin.
1 6-spindle Quint.
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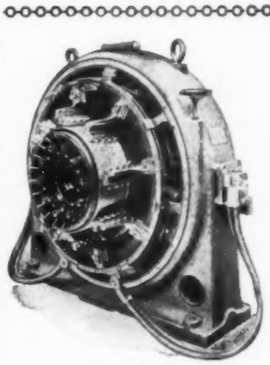

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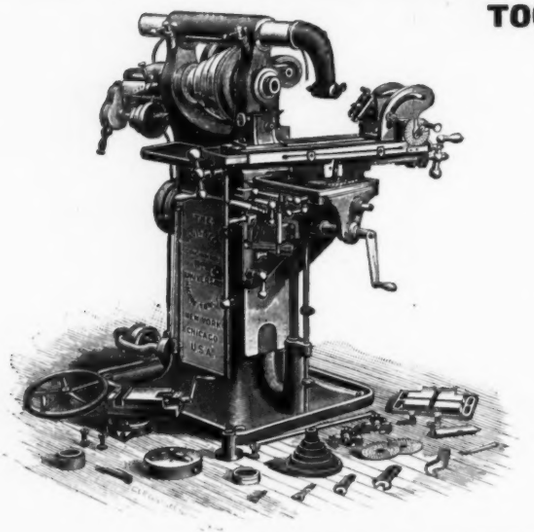

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Wide Face and Large Diameter of Cone.

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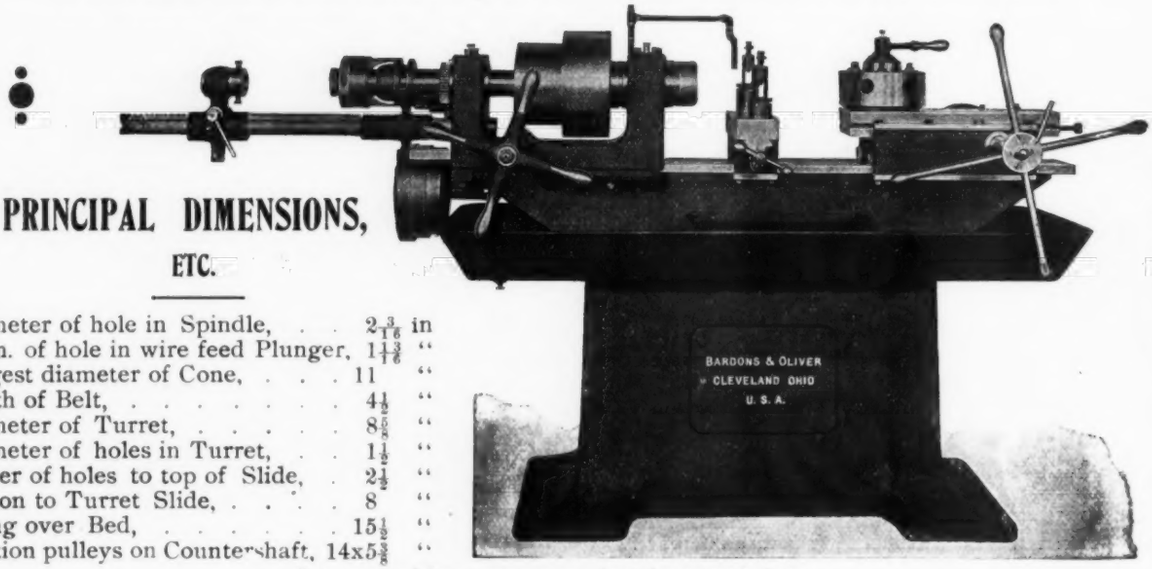

PRINCIPAL DIMENSIONS, ETC.

Diameter of hole in Spindle,	$2\frac{3}{16}$ in
Diam. of hole in wire feed Plunger,	$1\frac{13}{16}$ "
Largest diameter of Cone,	11 "
Width of Belt,	$4\frac{1}{2}$ "
Diameter of Turret,	$8\frac{5}{8}$ "
Diameter of holes in Turret,	$1\frac{1}{2}$ "
Center of holes to top of Slide,	$2\frac{1}{2}$ "
Motion to Turret Slide,	8 "
Swing over Bed,	$15\frac{1}{2}$ "
Friction pulleys on Countershaft,	14x$5\frac{3}{8}$ "

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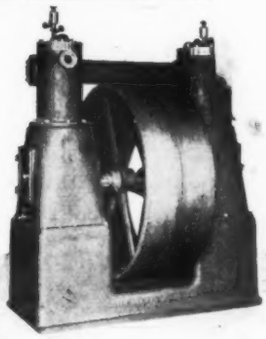
No. 4 1-2 TURRET LATHE.

No. 4 1-2 TURRET LATHE.



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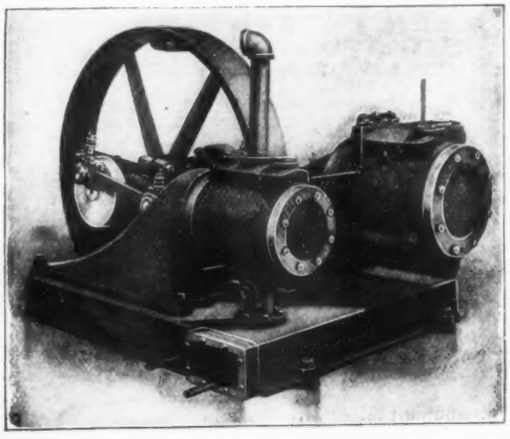

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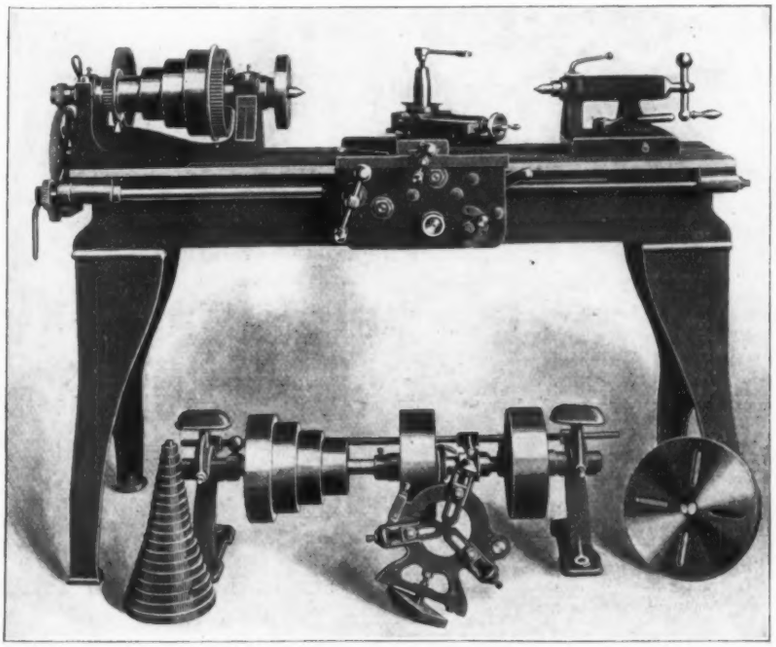

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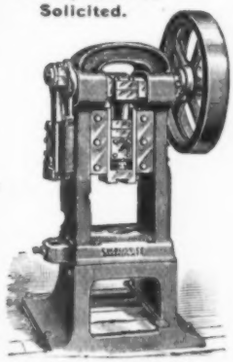

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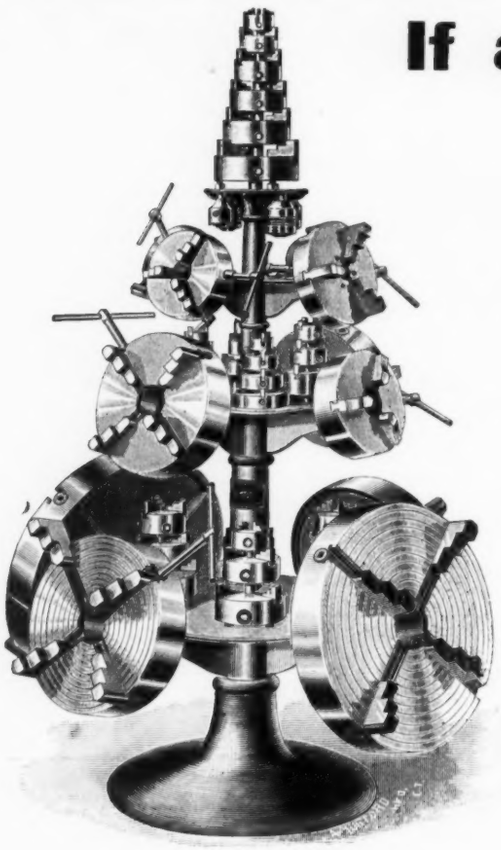

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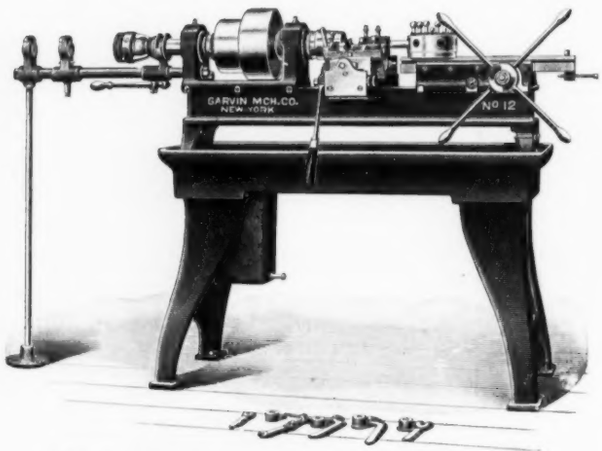

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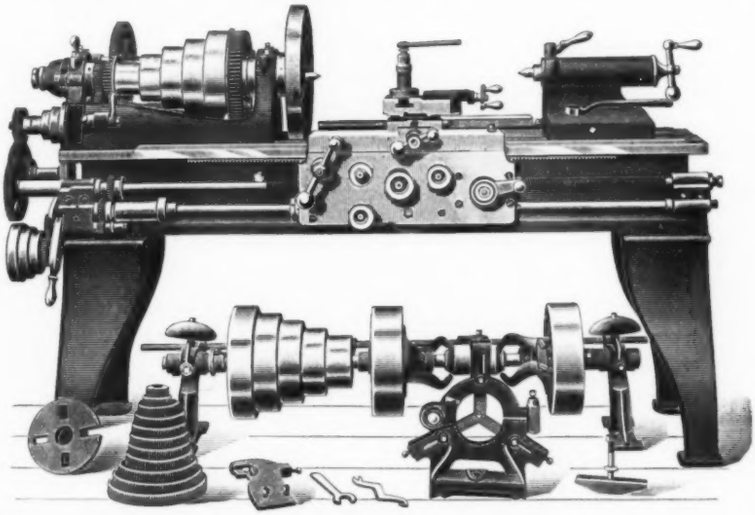

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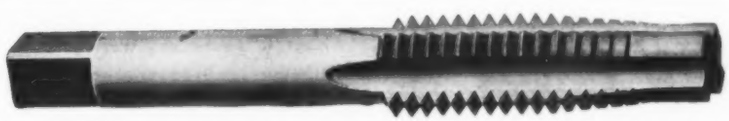

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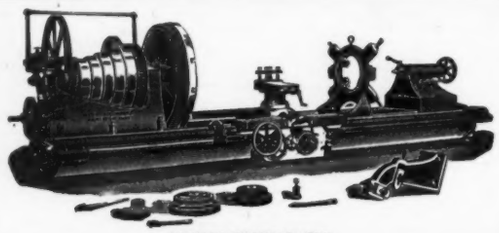

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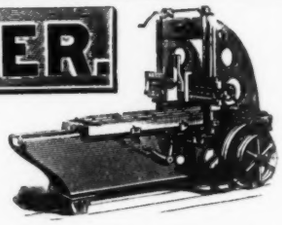

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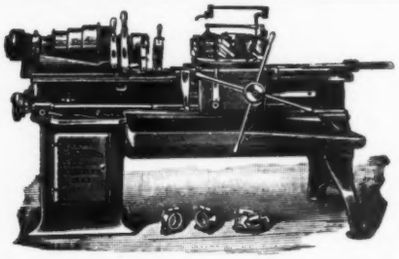

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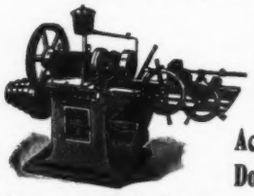

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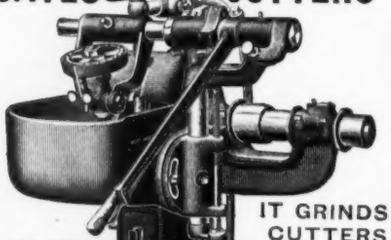

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